THE HEATING AND VENTILATING MAGAZINE

1123 BROADWAY NEW YORK JULY, 1907

Central Heating and Ventilating Plant of the Stock Exchange at Budapest*

BY CHARLES KNUTH, JR.

The new building of the stock exchange is situated in a large square called "The Square of Liberty," and is open on all its four sides.

It comprises within itself the stock exchange and the grain exchange.

The main parts are the two great halls, which have the unique features of being situated on the first floor. Each of the two abuts on an oblong colonnade hall, and these two are united by a Pantheon-like central hall which can be reached from the outside by two main staircases.

Attached to the stock exchange and the grain exchange are offices for the management of the whole service, the arbitration court, the giro company's offices, the post office, telephone and telegraph offices, the rooms serving for the recreation of the members and the public, smoking rooms and coffee house, etc.

Besides this there are shops on the ground floor which do not belong strictly to the stock exchange, and on a fourth floor—the top floor—are private suites of rooms not centrally heated occupied by the families of the officials of the stock exchange.

FOUR GROUPS OF APARTMENTS

From the point of view of the heating engineer there were four groups of apartments to be considered.

1. Rooms containing many people for a strictly determined time and not in use for the rest of the day.

2. Rooms containing many people for a not strictly determined time and sometimes used for 18 hours a day.

3. Rooms containing few people for a long time.

4. Rooms containing few people for a short time.

It is not possible to classify the rooms exactly for every day, but on the average day the rooms belong distinctly to one or other of the above-mentioned classes.

The relative importance of the four groups can be judged by the following figures:

Cubic contents to be heated, 3,928,-100 cubic feet.

Group I contains:

Stock Exchange Hall, 706,000 cubic feet.

Grain Exchange Hall, 706,000 cubic feet.

Total, 1,412,000 cubic feet, or 36% of the total.

Group II contains the following rooms:

Two receiving rooms, each 18,000 = 36,000.

Two telephone rooms, each 25,800 = 51,600.

Smoking room, 22,500.

Conversation room, 26,500.

Buffet, 22,500.

Total, 159,100 cubic feet, or 4.1% of the whole.

III. All the offices of the president, vice-president, council, secretaries, arbitration court, private banks, lawyers' rooms, library, dressing rooms toilet rooms and cloakrooms.

*From a paper read before the Institution of Heating and Ventilating Engineers, London, England, June 25, 1907.

Total, 1,578,900 cubic feet = 40% of total.

IV. The rest—staircases, central hall, communicating halls, corridors. Total, 778,100 cubic feet, or 19.90% of total.

Besides this classification, which has reference chiefly to the purposes for which the various rooms are employed, there was to be considered the great extension of the building in horizontal as well as vertical direction. The building has ground floor, first, second and third floors, and has four almost exactly equal wings towards the four aspects—east, south, west and north. If we wish to bear in mind the different objects of the different groups of rooms and pay due attention to the proposed great extension of the building it seemed to be desirable from an administrative and economical point of view to use different systems of heating and ventilating for the different parts of the building.

FOUR DIFFERENT HEATING AND VENTILATING SYSTEMS USED

The heating medium is low pressure steam raised in a boiler plant placed exactly in the center of the cellar.

Following the four different groups of rooms we have:

1. Hot air heating combined with ventilation, plenum system while the halls are occupied, hot air heating with no fresh air supply, but air circulating by natural draught while unoccupied. The temperature and supply of air being under the sole control of the engineer.

2. Direct radiators in the rooms for heating besides this plenum system for ventilation, the heating being regulated by inhabitants, and the ventilation only being under control of the engineer.

3. Direct radiators in the room for heating, natural ventilation without heating chamber, both heating and ventilating being under control of user of room.

4. Indirect radiators for staircases using circulating air, direct radiators in other parts of this group. No ventilation.

These are the four systems of heating and ventilating the building which this paper is to describe; each of the systems is repeated several times, following the situation of the different localities to be heated and ventilated.

There were two main principles kept in view in arranging the whole apparatus:

1. To make the regulation and control of the different systems as efficient and easy as possible: this was attained by centralizing all valves of heating chambers and heating systems, thermometers and rheostats of the electric motors and damper regulators in one place (like a signal box on the railway).

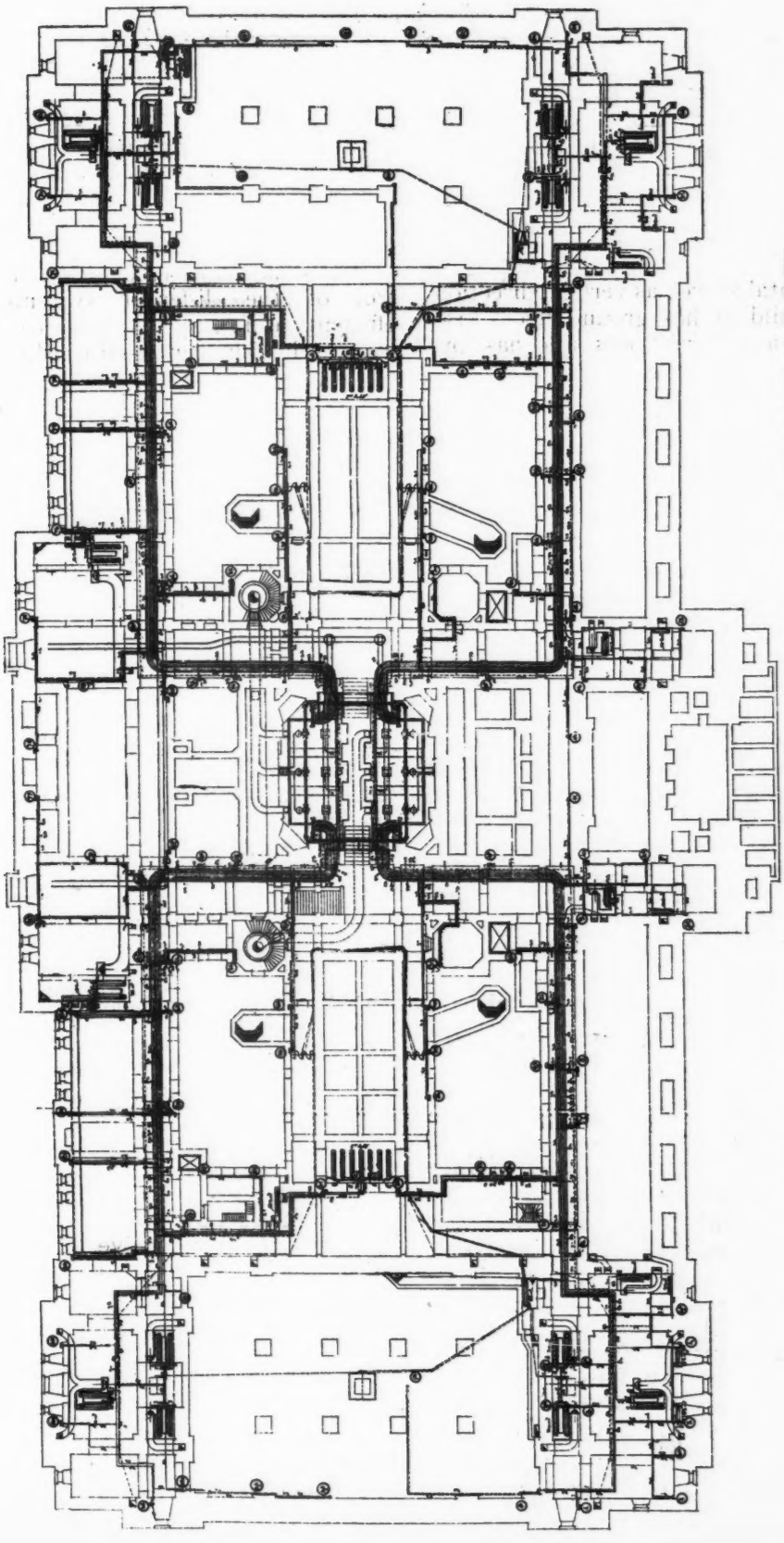
2. To make the coal bill as small as possible while fully complying to the requirements of a certain specified heating and ventilating standard: this was attained by dividing the pipes, the air ducts and the ventilators into as many groups as there were different services for different sections.

How completely the first object was attained will be evident from the fact that one engineer (of the capacity of a good foreman fitter) and two stokers work the whole service. The second object was also attained during the last two heating seasons—the amount of fuel used was only 49% of the guaranteed minimum.

In the following pages will be given the description of the four systems, a short discussion of the methods used for determining the loss of heat and the amount of heating surface necessary, one section dealing with the method of determining the sizes of pipes; and a short description of the two telethermometer systems used, and statistics.

DESCRIPTION OF SYSTEM I

Going into details of the description of the first group it seems necessary to the writer to demonstrate the importance of the economic value of combining both of the two air heating systems; *i.e.*, plenum system and circulating air-heating system by natural draught or mechanical means for one and the same locality.



BASEMENT PLAN OF BUDAPEST STOCK EXCHANGE, SHOWING HEATING AND VENTILATING SYSTEM

For the plenum system fresh air is taken from outside, warmed by heating surface of any description and propelled into the hall, generally by mechanical means, giving a slightly larger air pressure inside the hall than the external pressure. While this air is flowing into the hall, the air which has been there before must be displaced and is not used over again. If its temperature is higher than the outside temperature a quantity of heat is being lost proportional to the difference of outside and inside temperature.

If the arrangement is such that everything is left as in the plenum system with the only difference that the pressure inside the room is smaller than the pressure outside the room the system is called vacuum system, and exactly the same amount of heat is lost by it as in the plenum system.

Both of the two systems provide a fresh air supply inside the hall, and will be called "ventilating heating."

The relative merits of the two types of "ventilating heating" have been fully discussed at the meetings of this Institution, and it has only to be recorded here that the plenum system is used everywhere in the Stock Exchange of Budapest, where fans are employed.

If we propel hot air into a room and do not allow the foul air to pass out, but use it again by warming it up repeatedly, then we are employing the "circulating air heating" system. In this case there is no fresh air supply and no heat is lost by escape of warm air.

The difference in the cost of fuel is very great when comparing ventilating air heating with circulating air heating, and this difference is increased as the temperature of the air inlet is reduced.

COST OF VENTILATING AIR HEATING COMPARED WITH CIRCULATING AIR HEATING

The loss of heat with ventilating heating, as compared with circulating heating can be calculated as follows:

If

t_1 = temperature of air entering the room to be heated, in degrees Fahrenheit.

t_2 = inside temperature required, in degrees Fahrenheit.

t_3 = outside temperature, in degrees Fahrenheit.

t = temperature of air flowing to the heating apparatus, in degrees F.

c_i = B.T.U. absorbed by one cubic foot dry air per degree F. at the inside temperature.

K = cubic feet of air necessary to heat the room.

L = loss of heat with t_2 inside and t_3 outside in B.T.U. per hour.

H = amount of heat given by the heating apparatus to heat the room with t_2 inside and t_3 outside in B.T.U. per hour.

then generally

$$L = Kc_i\ (t_1 - t_2)$$

hence

$$K = \frac{L}{c_i\ (t_1 - t_2)}$$

This holds true both for ventilating and for circulating heating.

But there is a difference in H, the amount of heat necessary to supply the loss of heat.

The general expression for H is

$$H = Kc_i\ (t_1 - t)$$

For ventilating heating

$$t = t_3,$$

therefore

$$H = Kc_i\ (t_1 - t_3)$$

and for circulating heating

$$t = t_2,$$

therefore

$$H = Kc_i\ (t_1 - t_2)$$

The fraction

$$f = \frac{t_1 - t_3}{t_1 - t_2}$$

This shows how much ventilating heating is more expensive than circulating heating.

In our case the temperatures chosen were

$$t_1 = 114^\circ \text{ F.}$$
$$t_2 = 68^\circ \text{ F.}$$
$$t_3 = -4^\circ \text{ F.}$$

hence

$$f = \frac{114 - (-4)}{114 - 68} = 2.56$$

2.56%, that is, two and a half times more coal would be wanted for ventilating than for circulating heating.

For the English climate and the customary inside temperature the value of "f" is less prejudicial.

If we take

$t_1 = 114°$ F.
$t_2 = 62°$ F.
$t_3 = 32°$ F.

then we find

$$f = \frac{114-32}{114-62} = 1.57$$

In England generally only 57% more coal is wanted with ventilation than with circulation.

To find how the variation of the temperature of the entering air t_1 affects the coal bill, we consider the equation of "f."

If we substitute t_2 for t_3 with circulating heating we find

$$f = \frac{t_1-t_2}{t_1-t_2} = 1$$

which means that with circulating heating the variation of the inlet temperature of air does not affect the cost, or in other words with higher temperatures of inlet air less air is used, therefore the cost of fuel does not vary. The upkeep will be cheaper by using higher temperatures.

To consider the effects of change of t_1 with ventilating system, we again take

$$f = \frac{t_1-t_3}{t_1-t_2}$$

leave t_3 and t_2 constant and change t_1.

If we take two cases we can find following values of "f"

$t_2 = 68°$ F. inside $t_2 = 62°$ F. inside.
$t_3 = -4°$ F. outside $t_3 = 32°$ F. outside.

$t_1 = 160°$ F.	$f = 1.8$	$f = 1.3$
140°	$f = 2.0$	$f = 1.4$
120°	$f = 2.4$	$f = 1.5$
100°	$f = 3.2$	$f = 1.8$
80°	$f = 7.0$	$f = 2.6$
68°	$f = 8.0$	$f = 6.0$
62°	——	$f = 8.0$

This table shows for two cases how, as the inlet temperature is reduced, the ventilating system becomes gradually dearer than the circulating system, and that with cold climates the proper choice of the inlet temperature is more important than with moderate climates.

It is also evident that for a ventilating heating system with increasing inlet temperature the quantity of air decreases. The plant will become cheaper with very hot air exactly in the same rate as with circulating heating.

It can be shown that for a given plant the relation "f" varies very little with varying outside temperatures, and "f" therefore can be accepted as the characteristic of any given plant.

While generally in engineering practice an increased first cost is accepted in order to lessen the working expenses, here we find the contrary: with increased first cost the working expenses are also increased. The only advantage in raising the first cost of the heating plant is the improvement of the hygienic conditions which we gain by using ventilating heating instead of circulating, by using low inlet temperatures instead of high ones and by giving a great instead of a small quantity of air. Every one deciding the scheme of an air heating plant has to consider not only the size of heating surface and the quantities of air supplied, but it is extremely important to calculate the working expenses and inform purchasers of the probable cost of upkeep. Then, generally, a compromise is arrived at between the demands of hygiene and the amount clients are willing to spend.

DETAILS OF SYSTEM I

The general scheme for Group I is shown in Fig. 1. This figure shows the way the air circulates when using ventilating heating.

The air is taken from each of the four courtyards. It would have been preferable to take it from the park outside, but this was not allowed by the Town Council.

The air is not filtered, washed, nor moistened artificially.

It is passed through four 7′ x 7′ dampers, which are worked from the signal box by a winding mechanism conveying the motion to two wire ropes, one leading forwards, the other backwards. The actual amount of

the opening is shown on a dial at the winding center. Two fresh-air dampers are worked simultaneously.

To heat up the halls the air is heated first by tempering coils to 50° F. The temperature of this air can be read by a galvanometric telethermometer in the signal box.

The tempered air passes through ducts 8′ x 10′, and increasing to 8′ x 24′ to the different heating chambers.

These heating chambers heat up the air exactly according to the specific requirements of the different halls. No heating chamber serves more than one hall, the big halls are each served by four heating chambers.

The heating chambers consist of a space containing two coils; the air passes once forward, turns to the left passes through the second coil and ultimately reaches the fan. Extending from this is a very short horizontal air duct, the longest not measuring more than 15 feet; then a vertical shaft through which the air reaches the hall.

Temperatures of hot air can be read by a galvanometer in the signal box.

The natural velocity of the air in the air ducts is great enough to carry sufficient heat without the aid of a fan whatever the outside temperature, and it is only when a certain determined quantity of air is demanded for ventilating purposes that fans are put into motion.

The rheostats of all ventilators are set in the signal box and each is supplied with an incandescent lamp. The lamp does not glow if the current is not closed, that is if the fan is not running, and according to the resistance in the rheostat it glows very dark red, later cherry red, yellow, and at last white, thereby showing the speed of the fan.

This device provides an optical indicator of the speed of all fans, 16 of which are running. The engineer thus knows at a glance how much air he is giving everywhere.

As we have seen, the heating alone costs nothing for electric current, only the ventilation uses electric power.

There are no bypass dampers at the fans because for heating purposes alone the small resistance caused by the fan itself when standing is of no importance in checking the circulation of air.

The fans are of the Blackman type, directly connected with the continuous current electro-motors, and it generally happens that the natural current of air when passing through the fans moves them like the wheel of the anemometer at a speed of about 30 revolutions a minute.

The air enters the room by registers situated not lower than 7′ above floor level.

The temperature of the air can be read by a maximum and minimum thermometer at the signal box.

A special feature of this maximum and minimum thermometer is that its maximum as well as its minimum can be chosen and altered by moving a little screw. The minimum in most rooms is set to 67° F. and the maximum to 68° F. There is a bell signal and an indicator worked by the thermometer in each room. The bell sounds first when the minimum is reached and continues ringing till it is stopped by the engineer. The room is then at the proper temperature, being above the minimum and below the maximum.

When the maximum bell is ringing it is a sign that cooling must start, which means that the temperature of air blown in must be lower than 68° F. As the engineer has in his hand means for controlling exactly the quantity of air with the aid of the fan as well as the temperature of air blown in, the cooling can generally be effected in a very short time.

As soon as the minimum signal of any room appears on the indicator, that room's heating chamber steam supply is entirely stopped or half stopped according to the outside temperature.

Cooling experiments have shown that at an outside temperature of 4° F. during an 11½ hours' stoppage of the entire heat supply the inside temperature dropped on the average for all rooms 7° F. The air outlets were all closed during the test. This figure shows that it is easy to reach the minimum temperature in all rooms

at any required time. In fact in testing the apparatus between 8 A. M. and 8.10 A. M. one of the minimum signals after the other appears showing that it is in proper working order. If one of the signals is missing at the signal box the fan is quickly turned on to accelerate the test.

The two big halls have four heating chambers and four fans each.

While heating up, the fresh air inlet No. 3 of Fig. I and the extracting duct damper No. 14 on the top is closed and the return damper, No. 15, is opened. This is the circulating heating used as long as the hall is empty. As soon as business opens

The dampers in the extracting ducts are very important parts of the system in an economic respect because the saving of coal can be only effected by closing them as soon as possible. These dampers are about 360 feet distant from the signal box, and had to be designed to work by wire rope transmission.

This system of the supply of heat and air is repeated twelve times in the building, and with it the whole set of apparatuses as well.

The air ducts are of such sizes that by circulating air at 113° F. they can (without mechanical means) supply sufficient heat to warm the rooms

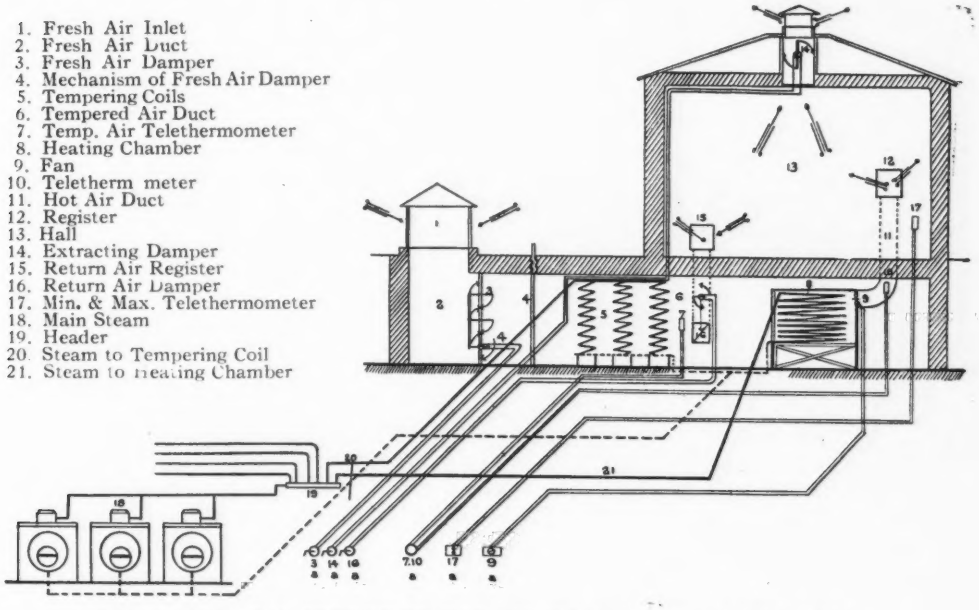


FIG. 1—GENERAL SCHEME OF HOT AIR HEATING FOR LARGE HALL

the fresh air damper as well as the extracting shaft damper must be opened by the engineer in the signal box. The return air damper can be shut after a time, but it does not much affect the passage of the air even if left open, as the air will always take the line of least resistance.

In the grain exchange up to 12 noon ventilating heating is used; business ceases at that hour, and members walk over to the hall of the stock exchange. At 12.15 P. M. the grain exchange is empty and the change to circulating heating without fans is at once effected.

to 68° F. when the temperature outside is —4° F.

The fans supply 17 cubic feet of fresh air per head per minute. In the smoke rooms the supply is 28 cubic feet per head per minute.

The heating chambers are sufficient to supply the heat necessary at —4° F. outside and are able to heat up the specified quantity of fresh air to a varying blowing in temperature when the outside temperature is 14° F. With lower outside temperatures the amount of fresh air must be reduced.

The cubic contents of each of the great halls is 706,000 cubic feet; they each can hold 1,000 persons and require 420,000 B.T.U. per hour if maintained at 68° F. when the outside temperature is —4° F., that is, about 0.59 B.T.U. per cubic foot per hour without any ventilation. This figure is a very low one compared with other rooms of this building, which require mostly 1.4 B.T.U. per cubic foot. This figure is also small compared with corresponding figures determined for other buildings of lighter structure, where it very often reaches 2.2 B.T.U. per hour.

The B.T.U. for heating only at —4° F. is much less than the B.T.U. for heating and ventilating combined at 14° F. This amount of heat is found as follows:

$$\text{Loss of heat at } 14° \text{ F.} = \frac{420{,}000}{72} - 54 =$$

314,000 B.T.U. per hour.

Air supplied $= 17{,}000 \times 60 =$ 1,020,000 cubic feet per hour.

Heat necessary to heat 1,020,000 cubic feet from 14° F. to 68° F. $= 1{,}020{,}000 \times 54 \times 0.018 = 991{,}440$ B.T.U per hour.

Loss of heat to cover heating and ventilating $= 991{,}440 + 317{,}000 = 1{,}305{,}440$ B.T.U. per hour.

The four heating chambers of one great hall are calculated to give together 1,305,440 B.T.U., and are therefore three times more powerful than necessary to heat the great halls at —4° F. outside without ventilation.

DESCRIPTION OF SYSTEM 2

We have now to consider the second group using direct radiators for heating and pure plenum system for ventilating.

The plenum system works with a similar set of apparatuses as in Group I. It follows therefore that damper-movements, telethermometers of air ducts, and maximum and minimum telethermometers in rooms, valves for separate steam pipes to each heating chamber are located centrally.

No circulation is attempted with this system, as its aim is only to supply fresh air of 68° F. or only a few degrees lower or higher with an outside temperature of 14° F. The heating chambers were tested at an outside temperature of 5° F. this winter and could still supply the amount of air specified with 14° F. This system is repeated four times.

The direct radiators are of single-column and of double-column type, and are distributed in the window recesses.

The system of low pressure steam heating employed is the gravity circulating system. Each radiator is provided with a separate flow and return pipe.

There are main steam pipes for every floor and main steam pipes for every aspect, giving a total of 16 main steam pipes.

This is a special feature of this building, and was only recommended in order to save fuel because it was known that the groups would be used at different times.

The return pipe is common to all floors; it is above the water level as far as local circumstances permitted it, dropping below the water level only where it was necessary.

The pitch of the supply pipe is downward from the boiler and arranged in such a manner that the water of condensation will move in the same direction as the current of steam.

Drips lead away the condensation water at every relay and every riser.

No air valves are used.

The air is allowed to pass out of the main return pipe at convenient places so long as the return pipe is over water level. Where this is not the case the return risers are branched off to a separate air pipe system which terminates at four points. The diameter of the air pipe is $\frac{3}{4}$ inch, increasing to 1 inch.

The two connections of the radiators are on the same side, and it has been found that even a radiator of 52 sections became hot throughout. The temperatures of the surface of the radiator are not uniform, they are higher at the top than at the bottom, the difference depending on the pressure of steam.

During cold days, with the outside temperature below 10° F., the pres-

sure at the boilers is 1-10 atmosphere or about 1.5 lbs. per square inch, while at the same time the pressure at the inlet of the radiator is calculated to be 1-1,000 atmosphere or 0.015 lbs. per square inch.

In the return pipe there is no pressure at all.

At temperatures of 32° F. and higher the boiler pressure is reduced. It is possible to heat the most distant radiator with a boiler pressure of 0.2 lbs. per square inch.

Each radiator has one steam valve at the top and no valve at the bottom. The steam valve has besides a cylindrical cock for opening and shutting a sliding disk moving in a slot of the cock in order to adjust the absolute size of the opening. This is necessary to counteract the unavoidable differences of inlet pressure. The pressure ought to be the same at every radiator, but this can not be attained exactly according to calculation because steam pipes can only be obtained of certain standard commercial sizes, and there are no sizes between them. During the first winter the secondary sliding disks were adjusted as it proved necessary at different places.

To make the adjusting process easy there is a tee-piece fitted into the return pipe just at the return side of the radiator and closed with a plug. While adjusting the steam valve the plug has to be taken out, and by this it is possible to watch the flow of the condensation water.

The steam valve is set right if the water in the return pipe is flowing about $\frac{1}{8}$ full. All the rest of the return pipe is filled with air.

The pipes are laid in recesses in the wall, which are covered with bricks after finishing the pipe work.

DESCRIPTION OF SYSTEM 3

The third group of rooms has outlet registers for ventilating purposes. No warming of fresh air is used. The outlet registers are placed, one 6″ above the floor and one in the same flue 6″ below ceiling.

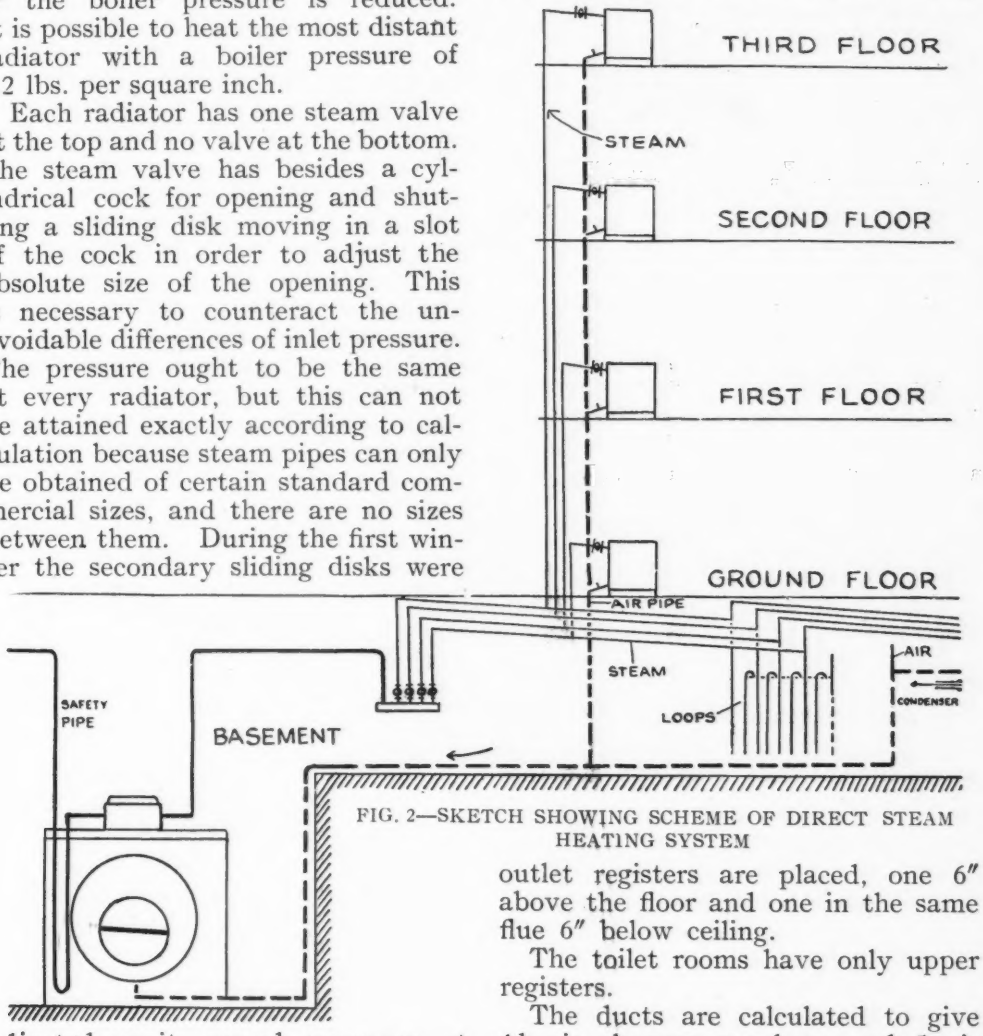


FIG. 2—SKETCH SHOWING SCHEME OF DIRECT STEAM HEATING SYSTEM

The toilet rooms have only upper registers.

The ducts are calculated to give $1\frac{1}{2}$ air changes per hour and 5 air changes at the toilet rooms at a difference of temperatures between inside and outside temperatures of 18° F.

The heating surfaces are ample (besides supplying the heating to provide for the warming up of the desired amount of air) even at an outside temperature of 14° F.

The heating is done by direct radiators as in System 2.

DESCRIPTION OF SYSTEM 4

The fourth group has no ventilation at all. Direct radiators heat the corridors and cloak rooms. The staircases have indirect heating only, with circulating air. Six heating chambers for this purpose have been built. These heating chambers are connected to the ground floor by direct heating steam pipe systems.

Adding up all systems there are: Steam system—

2 tempering coil batteries.
16 to heating chambers.
16 to direct radiators.

—

34 systems of steam mains.
12 heating chambers with fans, telethermometers, distant moving dampers and
4 ditto only for ventilating.
6 heating chambers, no ventilating.

All dials of instruments, lamps, bells indicators, rheostats, steam valves, are collected in two signal boxes which are situated at opposite ends of the boiler room.

BOILER ROOM

The boiler room is in the center of the heating plant. There are six boilers of the Cornish type with two additional smoke pipes, having each a heating surface of 400 square feet. Fuel can be supplied from the top and from the ordinary front fire door. Generally the fuel is fed on the top by tilting a specially made coal car at the opening in the setting. There is a special rail track for coal transport from the coal bunkers to the boiler room. All boilers are connected to a ring main, from which are supplied the four headers.

Sizes of Steam Pipes

There have been read two interesting papers at the thirteenth annual meeting of the American Society of Heating and Ventilating Engineers on this subject, one by Mr. James A. Donnelly* and one by Professor William Kent.† Both papers gave tables for finding the size of steam pipes for a given steam quantity, but while the table in the paper of Mr. Donnelly shows the drop of pressure in separate columns, the two tables in Prof. Kent's paper are based on the drop at the rate of 1 lb. per 1,000 feet length of straight pipe, and for other drops we have to divide the number of pounds of steam to be carried by the square root of the drop in pounds per 1,000 feet, and then to select from the table the size of pipe required. It is obvious that the table of Mr. Donnelly is more practical from this point of view, while the table of Prof. Kent is better in that it gives the flow of steam in pounds per minute or per hour while the table of Mr. Donnelly gives square feet of direct radiation, which assumes a certain constant value, namely—three-tenths of a pound condensation per square foot per hour. For other values we have to multiply the figures found according to the different circumstances.

The tables of Recknagel's and Klinger's Almanac give size of pipe, drop and heat units, not square feet radiation—B.T.U. always having the same meaning. These tables are similar to the table of Mr. Donnelly and are much used.

TABLES USED FOR CALCULATING SIZES OF PIPES OF STOCK EXCHANGE

The most complete tables are to be found in Rietschel's Treatise, Table 19 A—D for low pressure steam. The original tables have G.S. units.

Instead of converting these tables of Rietschel's Treatise which were used for calculating sizes of pipes of the stock exchange heating there are given four diagrams converted into English measure and serving the same purpose.

1st Diagram Drop = 0 to 14 ounces per square inch. W = 0 to 600,000 B.T.U.

2nd Diagram. Drop = 0 to 300 ounces per square inch. W = 0 to 120,000 B.T.U.

3rd Diagram. Drop = 0 to 300 ounces per square inch. W = 0 to 1,200,000 B.T.U.

*Published in the January, 1907, issue of THE HEATING AND VENTILATING MAGAZINE.

†Published in the February, 1907, issue of THE HEATING AND VENTILATING MAGAZINE.

4th Diagram. Drop = 0 to 300 ounces per square inch. W = 0 to 12,000,000 B.T.U.

The method of calculating the size of steam mains requires three steps:

1. Choose boiler pressure.
2. Choose pressure at inlet of heating surface.
3. Determine sizes so as to exactly consume the whole pressure available.

The maximum pressure at boiler has been chosen to be 1-10 atmosphere = 1.47 lbs. per square inch = 23.5 ounces per square inch. The pressure at the inlet of the radiator has been chosen to be 1-1,000 atmosphere = 0.235 ounces per square inch.

The pressure at the inlet of coils in the heating chambers was taken according to Rietschel, and converted into English measures as follows:

Size of pipe = 1 inch inside.

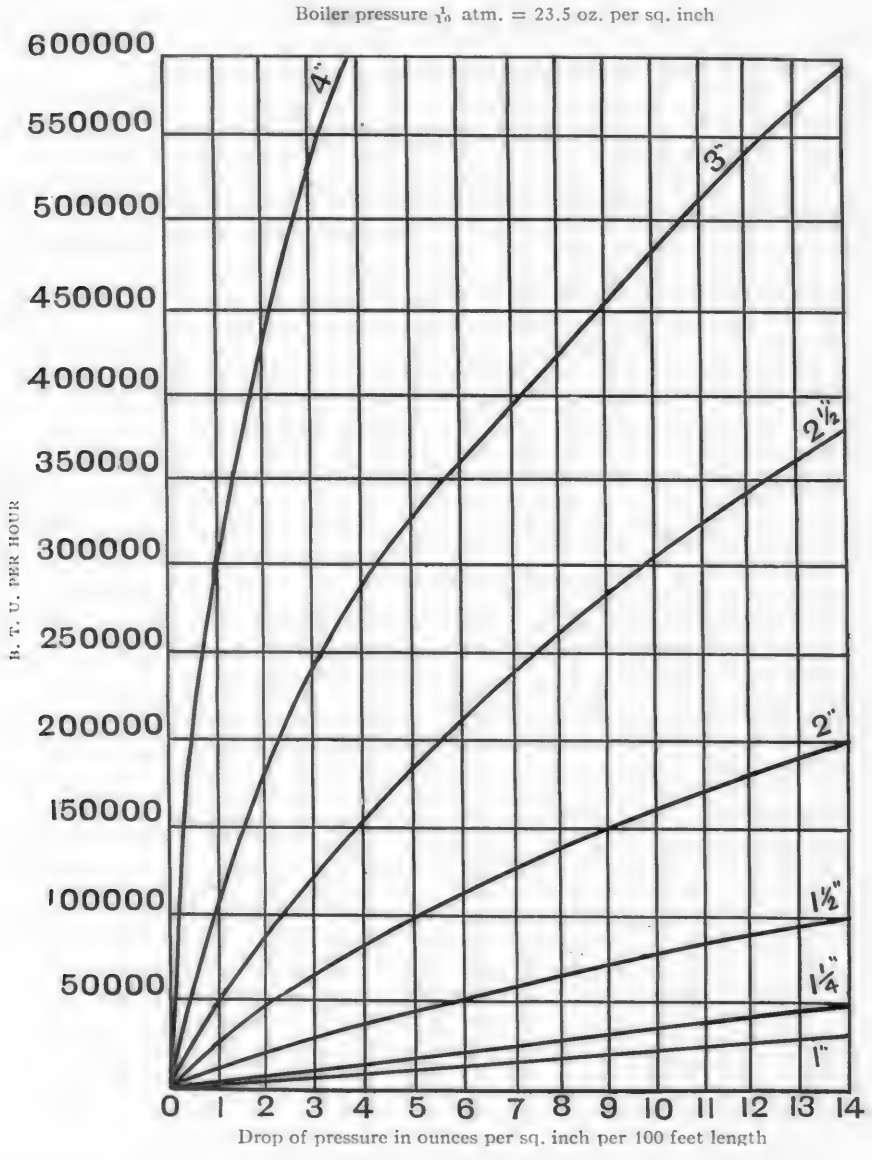


DIAGRAM 1—FOR FINDING PIPE SIZES FOR LOW PRESSURE STEAM HEATING

TABLE I, SHOWING ENTERING PRESSURE OF COILS REQUIRED IF PRESSURE AT END OF COILS IS ZERO

B. T. U. per hour.....	10,600	21,000	31,700	42,000	53,000	105,500	211,000
Entering pressure required ounces per sq. in.....	0.117	1.06	3.58	8.48	16.8	116	——

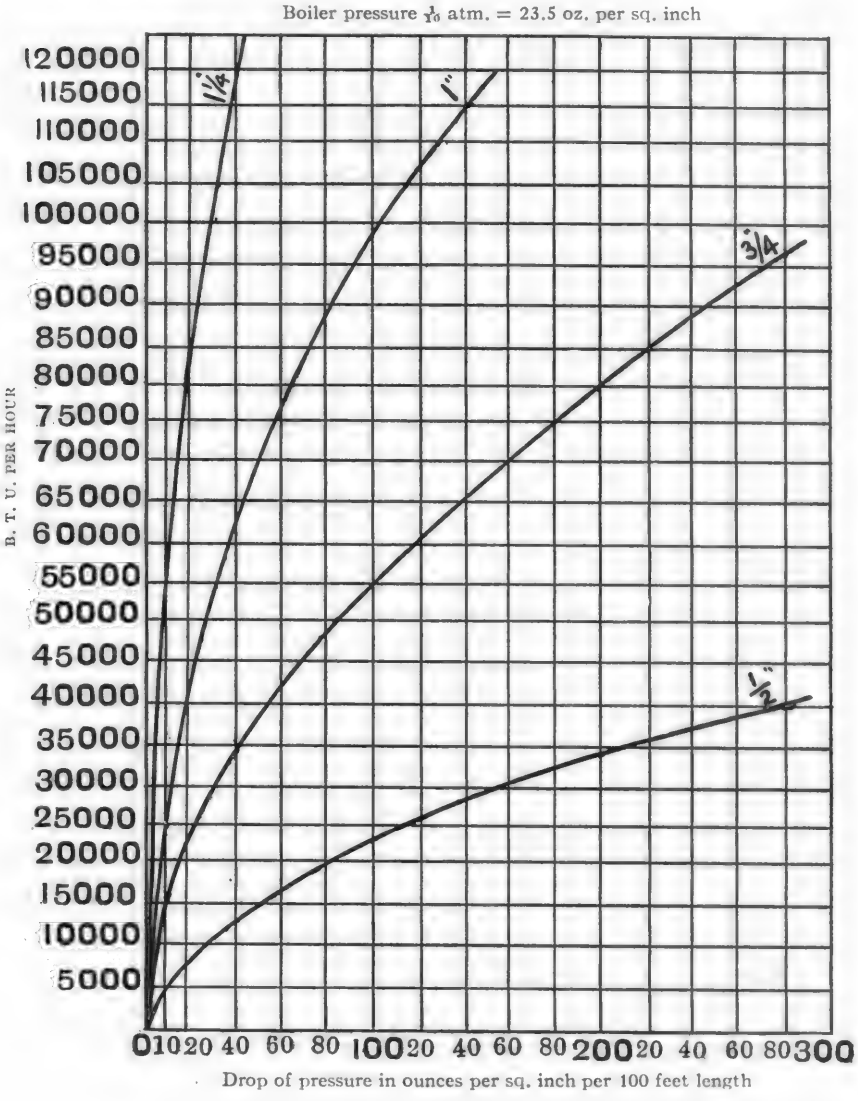


DIAGRAM 2—FOR FINDING PIPE SIZES FOR LOW PRESSURE STEAM HEATING

Pressure available from boiler to radiator:

23.5
— 0.235

23.265 ounces per sq. inch.

By the aid of the tables all pipes have been chosen in such a way that the whole pressure available shall be absorbed in the steam mains: it follows therefore that radiators near the boiler house will have a greater drop per 100 feet length than the distant radiators. By the aid of these tables the sizes are found very quickly. There are tables giving sizes up to 412,000,000 B.T.U.

EXAMPLE 1

Find size of steam main supplying one set of coils. Number of coils is four, each supplies 50,000 B.T.U. per hour. Boiler pressure 23.5 ounces

per square inch; pressure at end of coils is zero. Distance from boiler to set of coils, 150 feet.

Solution. From Table I we find by interpolating entering pressure required = 14 ounces per square inch. Drop available therefore:

EXAMPLE 2

Same B.T.U. to be supplied per hour: same distances, same boiler pressure as in Example 1, but use twelve coils instead of four.

Solution. Capacity of each coil = 200,000 ÷ 12 = 16,666 B.T.U. per hour.

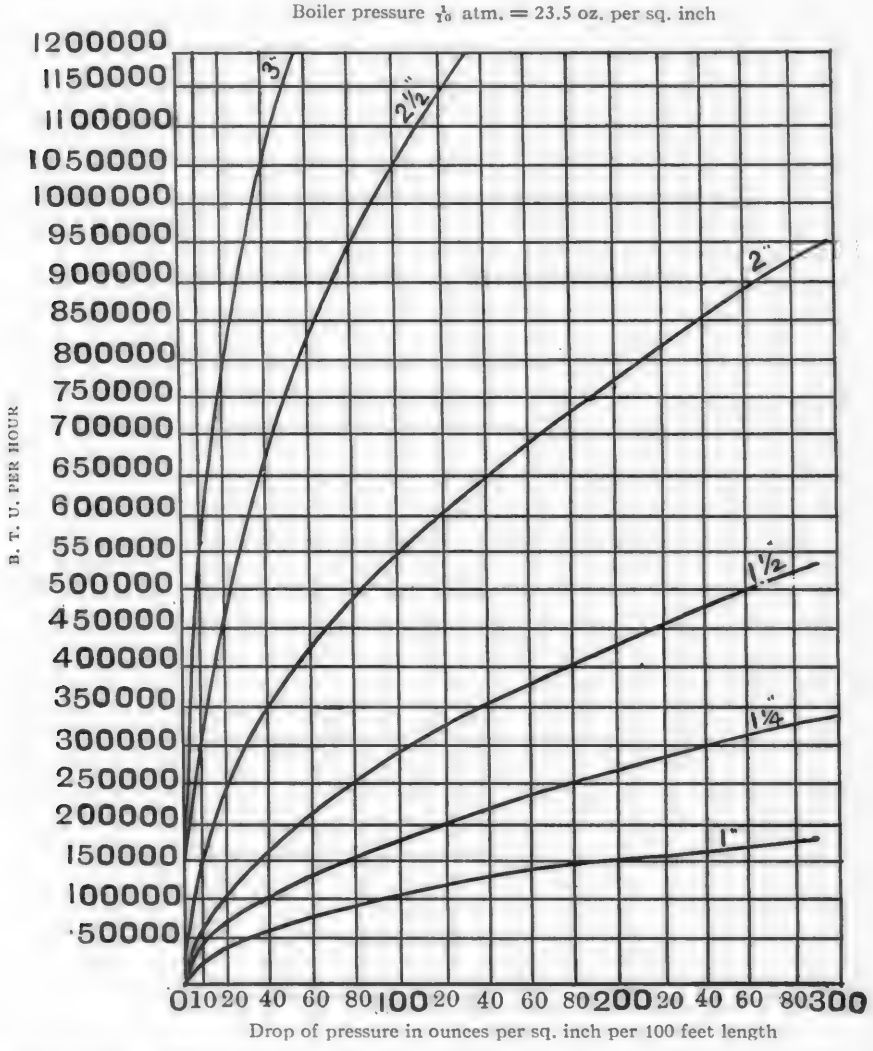


DIAGRAM 3—FOR FINDING PIPE SIZES FOR LOW PRESSURE STEAM HEATING

Drop = 23.5—14.00 = 9.5 ounces per square inch.

Drop available per 100 feet run = 6.3 ounces per square inch 100 feet.

B.T.U. supplied = 4 × 50,000 = 200,000 B.T.U. per hour.

From Diagram 1 we find a 2-inch pipe is not sufficient—we have to decide on a 2½-inch pipe.

From Table I we find by interpolating entering pressure required 0.7 ounces per square inch. Drop of pressure available:

Drop = 23.5—0.7 = 22.8 ounces per square inch.

Drop of pressure per 100 feet lengths = 15.2 ounces per square inch 100 feet.

B.T.U. to be supplied, 200,000 B.T.U. per hour.

From Diagram 3 we find size = 2 inches.

A 1½-inch pipe would not be sufficient even if the pipe had only to supply 200,000 B.T.U. per hour without any coils at the end.

assumed 0.235 ounces per square inch. Heating surfaces radiators, giving B.T.U. as indicated by figures in sketch. (Fig. 3.) Length of pipe given in feet.

At first we have to determine main steam pipe. The main has to carry

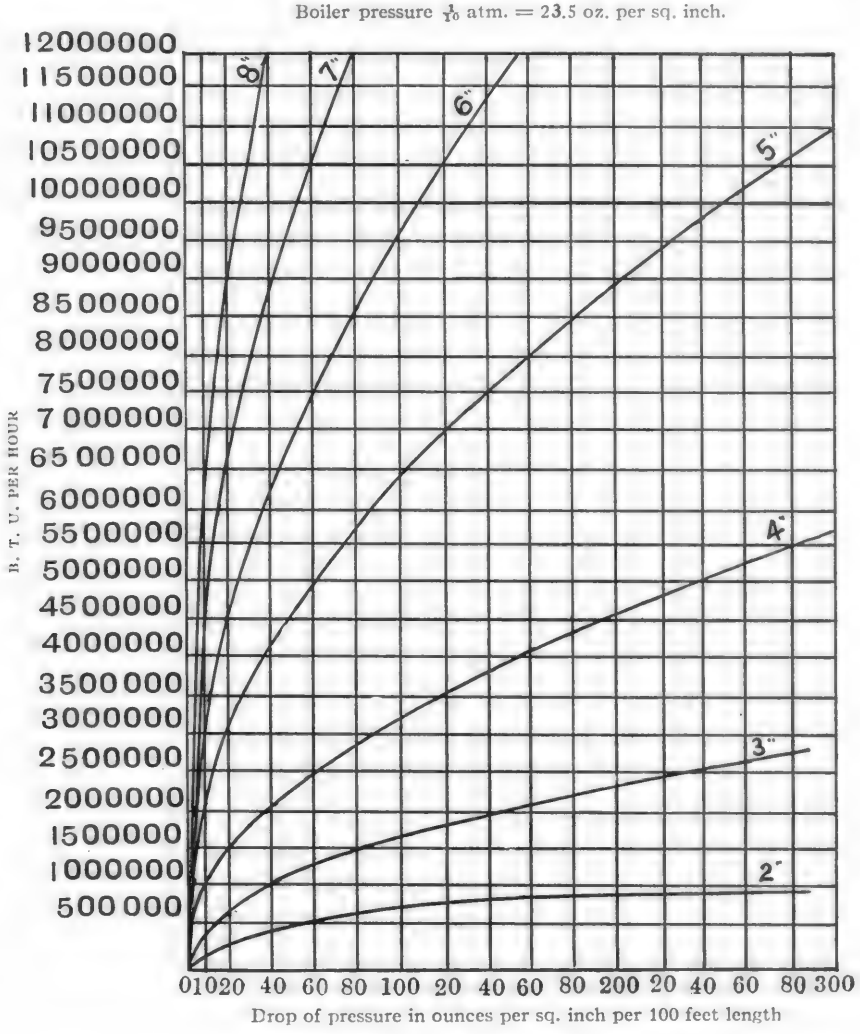


DIAGRAM 4—FOR FINDING PIPE SIZES FOR LOW PRESSURE STEAM HEATING

From Table I we find that one coil would not give 200,000 B.T.U. at a boiler pressure of 23.5 ounces per square inch even if the coils were quite near to it.

EXAMPLE 3

Boiler pressure assumed 23.5 ounces per square inch, entering pressure

B.T.U. as indicated on sketch below. (Fig. 4.)

We can assume drop of pressure available to be divided at a uniform rate but we could as well consume the pressure at any other rate, for instance, great drop per unit length at the beginning and small drop towards the end.

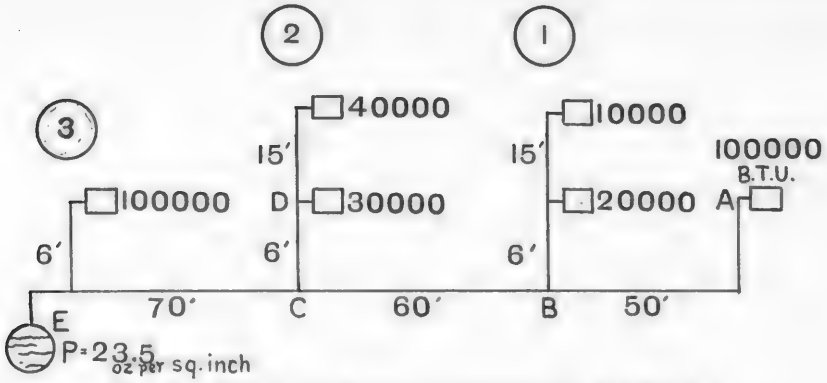


FIG. 3—SKETCH SHOWING CONDITIONS OF EXAMPLE 3

If we assume uniform rate of drop of pressure we find initial pressure = 23.5, end pressure = 0.235. Difference = 23.265 oz. per sq. in. Total length = 200 ft. Drop of pressure per 100 ft. length = 23.4 × 100 ÷ 200 = 11.7 oz. per sq. in.

From Diagram 1 we find:

100,000	B. T. U.	2 " pipe
130,000	B. T. U.	2 " pipe
200,000	B. T. U.	2½" pipe
300,000	B. T. U.	2½" pipe

The total real drop will be 13.06 oz. per sq. in. As can be found if we calculate the real losses according to the following table.

TABLE II

B.T.U. per hour	Size Assumed	Drop per 100 ft. found by Diagram 1	Length	Total drop calculated
100,000	2 "	5.5	50	2.75
130,000	2 "	7.5	60	4.50
200,000	2½"	5.5	70	3.85
300,000	2½"	9.8	20	1.96
			Total drop....	13.06

The total drop will be 13.06, while we can allow 23.265 oz. per square inch. We are justified, therefore, to assume smaller sizes. For instance, if we assume:

100,000 B.T.U. ..... 1½" pipe
130,000 B.T.U. ..... 2 " pipe
200,000 B.T.U. ..... 2 " pipe
300,000 B.T.U. ..... 2½" pipe

The real losses will be according to Diagram 1.

B.T.U. per hour	Size Assumed	Drop per 100 ft. found by Diagram 1	Length	Total drop Calculated
100,000	1½"	14.0	50	7.00
130,000	2 "	7.5	60	4.50
200,000	2 "	14.0	70	9.80
300,000	2½"	9.8	20	1.96
			Total drop...	23.26

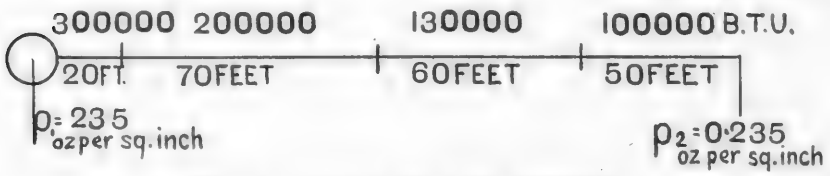


FIG. 4—DIAGRAM OF MAIN, EXAMPLE 3

The total drop will be 23.26 oz. per square inch. As the available drop is 23.265 the sizes of the steam mains are correct as assumed here.

CALCULATIONS OF RISERS

The risers are calculated in a similar manner.

Pressure at B has to be calculated first.

Pressure at A = 0.235 ounces per square inch.

$$\text{Pressure at B} = \frac{50 \times 14}{100} + 0.235 =$$

7.235.

Pressure at top of riser = 0.235.

Drop available in riser = 7.235—0.235 = 7 ounces per square inch.

Length of riser = 21 feet.

Drop available per 100 feet length = $\frac{7 \times 100}{21} = 33.3$ ounces per square inch 100 feet.

From Diagram 2 we find

30,000 B.T.U.	33.3 drop	$\frac{3}{4}$″ pipe
20,000 B.T.U.	33.3 drop	$\frac{3}{4}$″ pipe
10,000 B.T.U.	33.3 drop	$\frac{1}{2}$″ pipe

Riser No. 2.

$$\text{Pressure at C} = 7.235 + \frac{7.5 \times 60}{100} =$$

11.735.

Pressure at top of risers = 0.235.

Drop available = 11.735—0.235 = 11.5 ounces per square inch.

Length of riser = 21 feet.

Drop per 100 feet = 55 ounces per square inch 100 feet.

From Diagram 2 we find—

30,000 B.T.U.	55 drop	$\frac{3}{4}$″ pipe
40,000 B.T.U.	55 drop	1″ pipe
70,000 B.T.U.	55 drop	1″ pipe

The pipe leading to radiator D would have 1 inch pipe if we would assume uniform rate in riser itself and its branches alike.

$$\text{Pressure at D} = 11.735 - \frac{55 \times 6}{100} =$$

8.435.

Pressure at inlet of rad = 0.235.

Drop available in branch = 8.2.

Length of branch = 5 feet.

Drop per 100 feet available = 163 ounces per square inch 100 feet.

From Diagram 2 we find 40,000 B.T.U., drop 163, size $\frac{3}{4}$ inch pipe; instead of 1 inch pipe we may use $\frac{3}{4}$ inch pipe.

Riser No. 3.

$$\text{Pressure at E} = 11.735 + \frac{14 \times 70}{100} =$$

21.535 ounces per square inch.

Pressure at top = 0.235.

Drop available = 21.3

Length of riser = 6 feet.

Drop available per 100 feet = 350 ounces per square inch.

The values for drops of 350 ounces per square inch are not contained in diagrams, but we can conjecture from Diagram 2 that $\frac{3}{4}$ inch pipe will be sufficient.

It is interesting to compare size of steam main giving 100,000 B.T.U. at point A = 1$\frac{1}{2}$-inch pipe, while the same amount of heat requires only a $\frac{3}{4}$-inch pipe at point E.

Calculating according to this method gives correct sizes as far as five years' practice has shown. The table appearing in 1902. The exact calculations have two great values.

1. The sizes are equally correct for distant and for near radiators.

2. With changing initial pressure quantities of heat change at a very nearly proportional rate. It is not possible with ordinary steam heating systems to exactly vary quantities of steam supplied as wanted to suit exactly quantities of heat required with changing outside temperatures; but this is possible very nearly and quite sufficient for general use. The heating plant gave sufficiently proportional small B.T.U. at every radiator of the building when boiler pressure was only 0.0470 ounces per square inch. This is the working pressure on mild days.

It has been shown two years ago in the "Gesundheitsingenieur" how it is possible also to vary exactly the quantities of steam in each line of pipe by centrally varying the boiler pressure, but the methods used are too complicated for every day use in business both as regards calculation and regarding the coating and not coating of certain calculated length

of pipes in order to regulate the cooling losses; therefore more exact methods than those previously shown are seldom used.

Statistics

The building of the stock exchange covers 90,000 square feet; it has 95 apartments facing the street and 34 apartments looking on to the courtyards. It has 394 windows. There are 4,200,000 cubic feet to be heated. It requires for heating and ventilating a maximum of 10,000,000 B.T.U. per hour, that is, on the average, 2.38 B.T.U. per cubic foot per hour. There are six boilers, each with a heating surface of 400 square feet = 2,400 square feet, therefore each square foot has to supply 4,166 B.T.U. per square foot per hour.

The total heating surface is 13,600 square feet radiators and 11,400 square feet 1 inch coils, giving about 32,600 feet of 1 inch pipe in shape of coils.

The length of steam and condensed water pipes is 33,600 feet.

The cost of the whole building was £183,000. The cost of the heating plant was £10,000, or 5½% of the cost of the whole building.

Fuel consumed during season 1906-1907 was

Sept., 7.8 tons (metric)	°F. mean temperature.
Oct., 49.125	
Nov., 73.925	
Dec., 110.265	29.3
Jan., 127.450	27.7
Feb., 104.500	
March, 76.900	
April, 31.000	
Total, 581.465 tons.	° F. average.

Fuel—1,281,548 lbs. per year or 0.305 lbs. per cubic foot per year, ventilation included.

Compared with the guarantee, which was that the amount of fuel may not exceed 0.624 lbs. per cubic foot per year, accepting 32° F. as average temperature there is a saving of 51%. The guarantee was given without considering ventilation. It is very often found that the fuel burnt per year is 0.624 lbs.

The quantity of electric energy used for driving the fans varies very much during the year, and no rule can be found for its amount. The greatest consumption was on the 6th of April, 1907, *i.e.*, 217 K.W. per day, but the total for April, 1907, was only 2,188 K.W., giving an average of 72.6 K.W. per day. The greatest number of K.W. used was in January, 1907, when it was 7,156 K.W.

The ventilating and heating plant of the stock exchange has been in use since September, 1905.

SUGGESTIONS FOR IMPROVEMENT OF PLANT

All guarantees which were stipulated in the specification were fulfilled, and no alterations were necessary. But as in every heating job when in use a few years, there may generally be found details which would be differently specified if the work had to be done over again. There are three suggestions which could be proposed:

1. The corridors and staircases are found to be too cold at 64° F. inside, though 60° F. only was specified. They should be heated to 68° F.

2. The number of cubic feet fresh air supplied into the smoke room is not sufficient at the rate of 1,750 cubic feet per head per hour; 4,000 cubic feet per head per hour had been proved to be sufficient in another building.

3. The air passages in the basement are not tiled. It would be an improvement if they were. They would have been tiled very likely if it had been proposed, as the Council of the stock exchange liberally accepted every practical suggestion that tended towards the improvement of the whole work.

The architect of the building was Mr. Ignatius Alpár, of Budapest.

Mr. Knuth included in his paper a discussion of the methods used for calculating the heat losses from the Budapest Stock Exchange Building and also a description of the telethermometer, several of which are included in the heating and ventilating apparatus for this building. These two portions of his paper will appear in the August issue of THE HEATING AND VENTILATING MAGAZINE.

Capacities of Cast Iron Sectional Boilers*

By Kenneth Gray

A casual reference to a boiler-maker's catalogue appears to give the necessary information as to the the capacity of any boiler. But as a matter of fact this information, which possibly is accurate, is never complete. The capacity of a boiler is never constant. It is subject to variation from several causes. The quality of the fuel, the intensity of the draught, and, more important still, the duration of the test, at which its capacity was estimated—all have a considerable influence on the result.

For the first two causes the boiler maker cannot of course be responsible. But with regard to the third, all heating engineers should, and I believe, when its significance is more fully appreciated, will demand definite information.

Everyone is aware that the heating power varies with the amount of air which is being supplied to the furnace. If we require a high temperature, a large supply of air is necessary. The blast furnace and a smithy fire afford good examples of this, as do also the old-fashioned household bellows, which are sound in principle, although they are dying out of fashion. But in all these cases the effect of forcing the air through the furnace is to consume the fuel more rapidly, and it is here that the element of time creeps in. It is absolutely useless to say what the heating power of a boiler is unless we are also told how long the charge of fuel is able to maintain the amount of radiation given, under the heading "Actual heating power" at the desired temperature.

HEATING POWER OF AN UNATTENDED BOILER

In a power plant, where steam is being rapidly used, in some mechanical operation, and where it is economical to run your boiler at a high pressure, the nature of the circumstances demands constant and watchful care; and having this constant care, it is of course possible to continually replenish the fires. But in an ordinary heating apparatus, the circumstances are different. Our customers cannot and will not set aside to one of their men, unless it is an installation of considerable magnitude, the sole duty of stoking. What they require is a boiler which they can stoke over night and find still alight in the early morning. Because a boiler will maintain, say, 1,000 square feet of radiation at the desired temperature for five hours, it is not correct to rate its actual heating power as 1,000 square feet. What we want is a boiler to run unattended for eight or ten hours; and the catalogue rating should, to my mind, be the amount of radiation it can carry that time in severe winter weather.

Let us examine this more closely. We will suppose the above boiler is installed in an apparatus where there is 800 square feet of steam radiation and 200 square feet of exposed mains. The boiler is attached to a chimney, the draught of which will burn out the fire in five hours. If at the end of that time the fuel charge is not renewed, the fire will die out and the radiators become cold. This would naturally happen during the night, and in horticultural work the results might be disastrous. We should naturally appeal to the manufacturer, and he would maintain that the boiler will heat 1,000 square feet of surface, and in the present unsatisfactory state of boiler catalogues, he would be right, because the basis of his calculation is not stated. As a matter of fact this boiler on an eight-hour basis should only be rated at 625 square feet. The reason is that a 1,000 square feet of steam radiation, at a temperature of 220° F. will condense 300 lbs. of steam per hour, or 1,500 lbs. in five hours. If the evaporative power of the available fuel charge is 1,500 lbs. of steam, and the boiler must run without attention for eight hours, we must divide 1,500 into eight parts, which will give

*Paper read before the Institution of Heating and Ventilating Engineers, London, England, June 25, 1907.

187.5 lbs. of steam per hour for eight hours, and 187.5 lbs. of steam per hour will supply only 625 square feet of radiation and no more. In the same manner the ten-hour rating would be 500 square feet. This is assuming that one square foot of radiation will condense .3 lbs. of steam per hour with steam at 2 lbs. pressure.

VARYING EFFICIENCIES OF RADIATING SURFACES

It may be interesting here to refer to the amount of steam which various forms of radiating surface will condense, as it gives yet another instance of the complexity of the boiler rating question.

A series of tests, of a very effective type of radiator, gave the following results. I was not present at these tests, but I believe the method adopted was by carefully collecting and measuring the condensation over a period of one hour. The steam was at 2 lbs. pressure, and the results were as follows:

Steam condensed in lbs. per square foot per degree difference of temperature.

4-column	radiator,	.00166
3 "	"	.00177
2 "	"	.00181
1 "	"	.00226

Heat Radiated.

1.60 B.T.U.
1.70 "
1.74 "
2.10 "

With a temperature difference of (220-60) 160° F., and assuming the amount condensed to be constant for each degree, an assumption which is not strictly accurate, but is nevertheless near enough for practical purposes, the amounts condensed per square foot of surface per hour would be:

	Steam 160° F. difference of Temp.
4-column radiator	.26560 lbs. steam.
3 " "	.28320 " "
2 " "	.28960 " "
1 " "	.36160 " "

These results are instructive both to boiler makers and heating engineers. To the former it shows that even though a boiler is somewhat over-rated, it may yet be able to heat quite comfortably the stated amount of surface if it takes the form of four-column radiators, and quite fail to do so with single-column radiators; and to the heating engineer it shows that he will be able to maintain a guaranteed temperature with a smaller amount of radiating surface if he uses single-column radiators instead of four-column radiators.

The explanation of this is simple. Radiation takes place always at right angles to the tangent of any point of the radiating surface. The form of the four-column radiator is such that a large amount of radiant heat must fall upon the other heated surfaces in close proximity to it; all that so falls is lost. It does not assist in warming the room. It is only that which escapes directly into the room, without encountering any intervening portion of the radiator which does. In a three-column radiator the condition is better; in a two-column radiator it is better still, and in a single-column radiator, if it is of good design, you get the best result.

AIR SPACE BETWEEN RADIATOR SECTIONS

What is known as the Hospital Radiator is even better than the ordinary single-column. In this radiator the sections are rather wide apart, and this allows of a larger proportion of the heat rays passing freely away from the radiator. In addition to the radiant heat, heat is imparted to the air by contact. In this respect the boxed-in surfaces of radiators are effective, provided of course that there is an opening at the top of the sections to allow the heated air to pass freely away. It is rather an interesting fact that when ventilating radiators are used, the result of opening the ventilators, and so allowing the outside air to pass through, is a rise in temperature. There is yet another factor which complicates the question, and that is height. Two low radiators, say each of ten sections, will condense more steam than one

10-section radiator of twice the height. This is because the surfaces near the upper part of all radiators are surrounded by warmed air rising from below, and so reducing the heat emission. The taller the radiators the more this fact comes into operation. The best radiating surface of all is a single horizontal pipe. Here no radiant heat is lost, all the rays passing away at right angles to the pipe, in lines which radiate from its center. Therefore, if the capacity of a boiler is given in the form of square feet of pipe surface, we may be sure it will be capable of heating an equal number of superficial feet, in every other form of radiating surface.

It may appear that we have wandered somewhat from our subject. This, however, has been done intentionally, because, in order to clearly show what the capacity of a boiler really is, it is necessary to have a clear conception of heat emission, in its relation to boiler capacity.

TESTING THE CAPACITY, EFFICIENCY AND WORKING QUALITIES OF A BOILER

In testing a boiler for house heating or horicultural work, it seems to me we must consider it from three points of view, viz: (1) Its capacity; (2) Its efficiency; (3) Its working qualities.

On what does its capacity depend? It depends on the source from which the heat is derived, which is of course the fuel. This being the case, we look to the size of the fire-box, which should show the space available for the fuel, not the length × the breadth × the height from grate to the surface directly over the fire, but the length × the breadth × the height to which it is possible to charge the boiler with fuel. In the type of boiler with which we are dealing, with the feed door in the front, and the grate of reasonable length, as a rule a fair estimate of the depth of fuel charge is the distance from the grate to the center of the feed door, so that strictly speaking, the dimensions of the fuel space (or fire-box) are the length × the breadth × height from grate line to middle of feed door, the space above this being essentially the combustion chamber.

In some boilers where the feed door is near the top of the front section, you cannot of course fill to the middle of the door. A little practice and careful consideration will enable you to form a fairly accurate opinion.

Having determined the amount of fuel that our boiler will hold, we must remember that the total heat of this charge is not available. A certain portion of it must still be unconsumed when the time comes for replenishing the fires, and this will vary from 15 to 20 per cent., the former being approximately the amount where coke is being used, and the latter when coal. Having made this deduction we know exactly how many pounds of fuel we have to consume during the test. We have already considered the time for which it is necessary for this fuel charge to last, and decided it should be eight or ten hours. In basing our calculation we will use the former. As the heat loss from a building is calculated on an hourly basis, we must get our fuel down to an hourly basis, and therefore divide the number of pounds by eight. For example, we will assume a boiler which will hold 300 pounds of coke; 85 per cent. of this amount is 255 pounds, which divided by 8 gives practically 32 pounds, which is the amount available per hour.

Now that we have arrived at the number of pounds of fuel per hour, we must assume a certain calorific value per pound. Time does not permit of our considering the relative values of the different classes of fuel, and therefore in dealing with this subject we will assume a fair average to be 12,000 B.T.U.'s per pound.

We now come to the efficiency of a boiler, and the next question is to determine the proportion of these heat units that will be utilized. From numerous tests of these boilers, it has been found that it is possible to obtain an efficiency of 70 to 75 per cent.; in other words, that 8,400 to 9,000 B.T.U. are available per pound of fuel, of which the calorific value is

12,000 B.T.U. per pound. Knowing that the conditions under which boilers operate in general use are not so favorable as in a test, it would seem that 8,000 B.T.U. per pound would be a fair estimate for calculation. But here a great deal depends upon the design of the boiler, and our estimate is based on the assumption that the heating surface of all boilers is equally efficient. Due consideration, however, must be given to the fact that the surface in the fire-box and the combustion chamber is of much greater value than the more remote surfaces in the flues, and therefore it is incumbent on heating engineers to make a study of the relative efficiency of heating surface in different positions.

My own experience has been that a boiler with a large amount of direct heating surface and a reasonable amount of flue surface in general gives the best results, because it can be made to respond readily in case of a cold spell, and will give a good result when connected to an indifferent draught, such as is so often the case in horticultural work, and can be also kept in check with a sliding damper in the chimney, should the draught be excessive.

Having found that the available amount of heat per pound of fuel when burned in a well-designed boiler is 8,000 B.T.U. in the case assumed above, where 32 lbs. of coke is consumed per hour, we have $32 \times 8{,}000 = 256{,}000$ B.T.U. available per hour.

The above information may seem at first glance a rather long and complex calculation, but it can be condensed for practical purposes into a very simple form, which can be noted in a pocketbook and readily applied for both water and steam boilers:

	Water.	Steam.
Mean Temp. of Water and Steam (2 lbs. pressure) in Radiators	150° F.	220° F.
Temperature of air in rooms	60° F.	60° F.
Difference of temperature of air and heating fluid	90° F.	160° F.
B.T.U. emitted per sq. ft. per hour per degree of temperature (radiation coefficient)	1.6 B.T.U.	1.6 B.T.U.
Total radiation per square foot of surface	144 B.T.U.	256 B.T.U.

NOTE.—Measure fire-box (not including combustion chamber) to find amount of fuel, deducting 15 per cent. for coke and 20 per cent. for coal.

If 1 lb. of fuel is burnt in eight hours the available B.T.U. per hour will be $8{,}000 \div 8 = 1{,}000$. Therefore, 1 lb. of fuel will supply $1{,}000 \div 144 =$ say 7 square feet water radiation for 8 hours. Also 1 lb. of fuel will supply $1{,}000 \div 256 =$ say 4 square feet steam radiation for 8 hours.

In the example we previously mentioned, when we found the available fuel capacity of a boiler was 255 lbs., the number of square feet of radiation it will carry is:

255 lbs. coke $\times$ 7 sq. ft. = 1,785 sq. ft. water radiation.

255 lbs. coke $\times$ 4 sq. ft. = 1,020 sq. ft. steam radiation.

I hope I have succeeded in clearly distinguishing between the capacity and efficiency of a boiler. To put this more concisely I will say, the capacity of a boiler is the number of square feet of radiating surface it will supply (for eight hours) with one charge of fuel. The efficiency being the number of B.T.U. per pound of fuel burnt, and utilized for heating purposes, a boiler with a high heating capacity may yet have a low efficiency. The difficulty in designing a boiler lies in combining a high capacity with a high efficiency, and I can assure you it requires great skill and care and patient trial before this can be accomplished.

The third important feature that must be closely investigated is what I have called the "working qualities."

First of all there must be, in a water boiler, a rapid circulation of the water. This can only be secured by having small water ways so arranged that there is no possibility of the divided streams of water meeting each other. All should converge

through channels with easy bends towards the flow tappings. The more rapid the circulation the greater the heat transmission from the fire to the fluid, just in the same way that the heat emission from indirect radiation increases with the velocity of the air passing over it. I have a record of experiments on this subject which shows a heat emission of 3.42 B.T.U. per square foot with the air velocity at 3 feet per second, increasing to 4.94 B.T.U. at 6 feet per second, 6.93 at 12 feet per second, to 9.79 at 24 feet per second. This fact alone will show how greatly the efficiency depends on the design.

The same rule applies in a less degree to steam boilers. They must also maintain a steady water line for all pressures they are likely to be worked at. This means of course that no priming must take place. To secure this the flow tappings must be of such a size to keep down the velocity of steam passing from the boiler. If this is too great it will carry small particles of water with it. In both steam and water boilers it is essential that all surfaces are accessible for cleaning. The furnace doors must fit tight; and with the clinker doors should be ample for their purpose. The draught doors and regulating damper should be so designed that the amount of air passing through the fire can be accurately controlled. These are the chief features, and a heating engineer who has the interest of his customers at heart will inquire closely into them before selecting a boiler.

IMPORTANT POINTS REGARDING CHIMNEYS

In conclusion I will refer shortly to chimneys, which in this country are often so unsatisfactory. On the continent architects are more closely acquainted with the technical part of their work than is sometimes the case here, and accordingly they provide in a new building a chimney of suitable size and construction to ensure a good draught in the boiler.

I may say here, a good draught should give you a temperature of about 1,200° F. in the combustion chamber, and with this temperature a well-designed boiler will give from 300° to 500° in the stack. Every chimney should be fitted with a sliding damper, to cut down the draught if necessary to the right amount. When once its correct position has been ascertained, it should not be moved again, all regulation being done by the dampers on the boiler. For this purpose it is most advantageous to have an automatic draught regulator, which will maintain an even temperature in the boiler, prolonging its life and incidentally saving fuel, for the efficiency of a boiler varies with the draught.

The chimneys should be as straight as possible; a round section giving a better result than a square one. It should not be contracted in sectional area at any point. This often happens where the pot is fixed. Where the iron flue enters the chimney it should not be allowed to project beyond the thickness of the brickwork. Soot doors in chimneys should fit closely. The top should be carried up to a level which assures it will not be affected with down draught.

All these points are important to the heating engineer, because they are often held responsible for the unsatisfactory working of an apparatus which is entirely due to a faulty chimney. At the same time it is clearly the duty of an engineer to find out what kind of chimney is available for his apparatus, because it should guide him in selecting a suitable boiler. When he is in doubt about the efficiency of the draught he should select a boiler with a large direct heating surface and very little flue travel, for although a fair proportion of flue surface is useful when the draught is good, it is worse than useless when the draught is sluggish.

Let me add in conclusion, that we shall, I believe, be taking a step in the right direction, and I trust you will agree with me in this, when we unite in calling upon all boiler makers to furnish us with clear and definite statements of what their boilers are really able to do.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Semi-Annual (Mid-Summer) Meeting, Milwaukee, Wis., July 18 and 19, 1907

Acting on the excellent precedent of previous years in holding the mid-summer meetings of the American Society of Heating and Ventilating Engineers in the Middle West, the members this year chose Milwaukee as a meeting place, and there the society was in session, July 18 and 19 last.

Following is the programme as scheduled:

THURSDAY, JULY 18—MORNING SESSION.

Roll call.

President's address.

Reports of committees.

Paper—"Heating and Ventilating Cars," by E. R. Swan, Cedar Rapids, Ia.

THURSDAY, JULY 18—AFTERNOON SESSION.

Paper—"Heating and Ventilating a Group of Public Schools," by Samuel R. Lewis.

Paper—"The Design of a Plenum System of Warm Air Heating for a School or Office Building," by J. D. Hoffman.

Topics for discussion:

No. 1.—The relative efficiency and velocity in two air pipes, one having a vertical rise of 18 inches to a round elbow supplying a pipe running horizontal for 10 feet, the other having a uniform upward inclination of 18 inches in 10 feet.

No. 2.—The difference in capacity to be provided in warm air pipes where air travels at different velocities.

No. 3.—The relative size of hot air pipes carrying the same volume of air at velocities of 100, 150, 200 and 300 feet per minute.

FRIDAY, JULY 19—MORNING SESSION.

Paper—"The Combined Pressure and Vacuum System of Steam Heating," by George D. Hoffman.

PRESIDENT C. B. J. SNYDER, NEW YORK

SECRETARY WILLIAM M. MACKAY, NEW YORK

Topics for discussion:

No. 4.—The amount of radiation necessary to maintain 70 degrees in a building having movable glass and an excessive air leakage and in one having weather strips practically avoiding air leakage.

No. 5.—The chemical and physical properties of cast iron used in boilers and radiators.

No. 6.—The relative advantage of a wet or dry return to a boiler set at the end of a long, narrow building in a gravity system, and the advantage of extending the main a long or short distance beyond the last radiator connection.

No. 7.—The benefits derived from the use of fusible plugs in cast iron steam boilers.

FRIDAY, JULY 19—AFTERNOON SESSION.

Paper—"Formula for Pipe Sizes in Hot Water Heating," by Oliver H. Schlemmer.

Topics for discussion:

No. 8.—The advantages in efficiency and economy of one large or two smaller boilers for carrying the same large amount of radiation, assuming in either case ample capacity for the work.

No. 9.—The comparative fuel consumption of firebox boilers in brick setting and horizontal tubular boilers.

No. 10.—The size of standard firebox boilers which should be provided to supply 1,500 pounds of steam per hour for direct radiation at three pounds pressure, burning hard coal, with a sixty-foot chimney and good draft.

ENTERTAINMENT PLANS.

The entertainment plans included an inspection of the pipe-covering plant of the H. W. Johns-Manville Company Thursday morning, following the morning session, luncheon being served at the factory. In the afternoon automobiles were provided to take the ladies for a ride about Milwaukee.

On Friday, after the adjournment of the morning session, the plans included an inspection of the plant of the Johnson Service Company, where luncheon was served, the return trip being made in time for the afternoon session. Friday afternoon the ladies were taken to the Layton Art Gallery, the Public Museum and the Library. In the evening tally-ho coaches took the guests to White Fish Bay, where dinner was served, this function marking the climax of the entertainment plans.

Saturday morning a visit was planned to the plant of the Allis-Chalmers Company.

In the following pages will be found some of the papers read at the Milwaukee meeting. The remainder of the papers, together with the full report of the discussions and other proceedings, will appear in the August issue of THE HEATING AND VENTILATING MAGAZINE.

*Heating and Ventilating a Group of Public Schools**

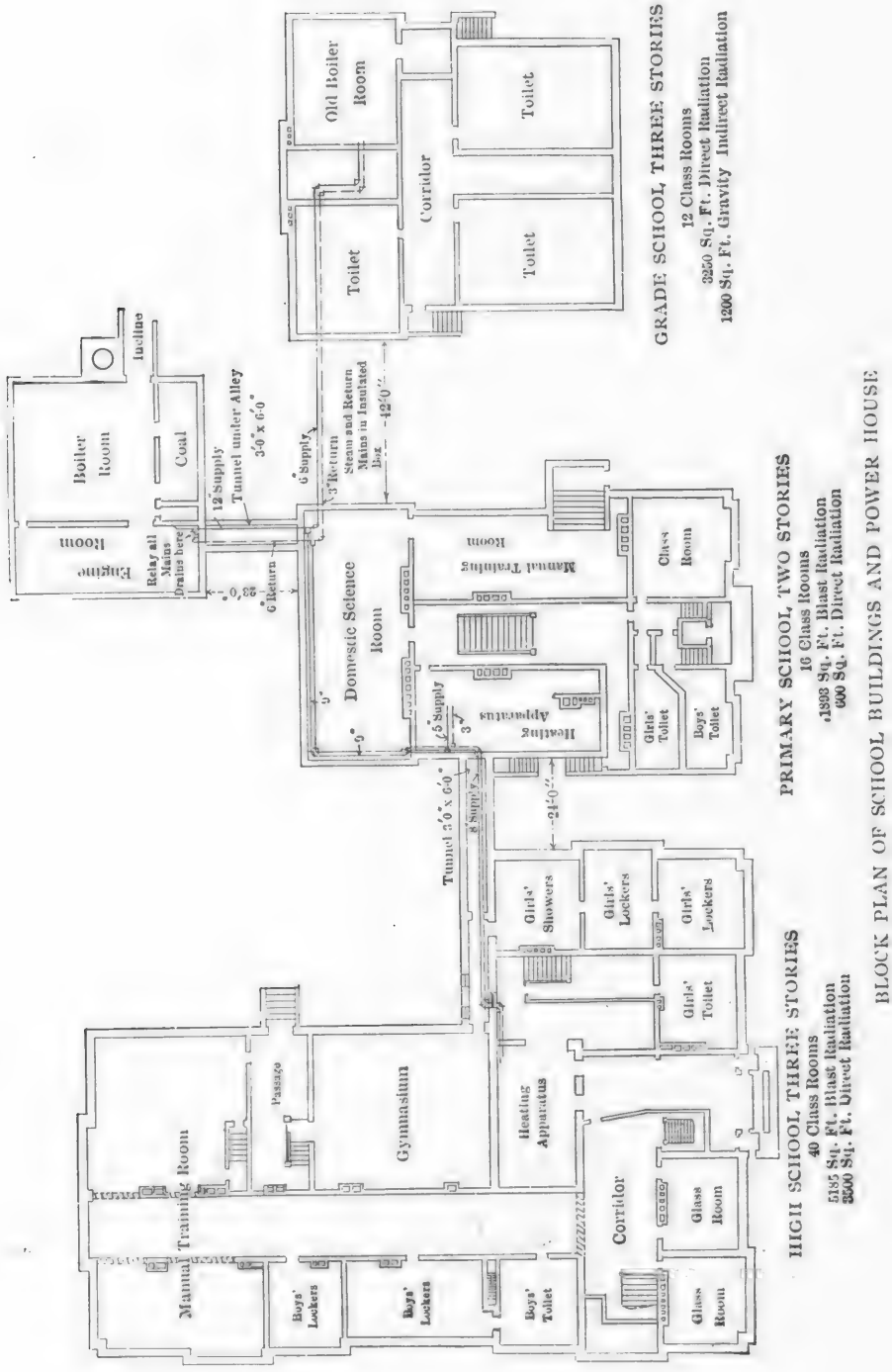
BY SAMUEL R. LEWIS

The buildings consist of a high school, a primary school and a grade school, all located in the same block. They are furnished with steam at five pounds average pressure for heating, with electric current for lighting and power, and with compressed air for various purposes from a common power plant, located centrally and owned by the Municipal School District. The plant is located at Galesburg, Illinois; was designed by the writer and installed by the firm he represents.

The primary school was completed a year before the high school, and was heated during that time with exhaust steam from a central plant which furnishes power for street railways and electric lights.

The heating plant in this building consists of a standard blast steam equipment, with direct radiation in the toilets, offices and corridors only. This

*Paper read at the Semi-Annual Meeting of the American Society of Heating and Ventilating Engineers, Milwaukee, Wis., July 18-19, 1907.



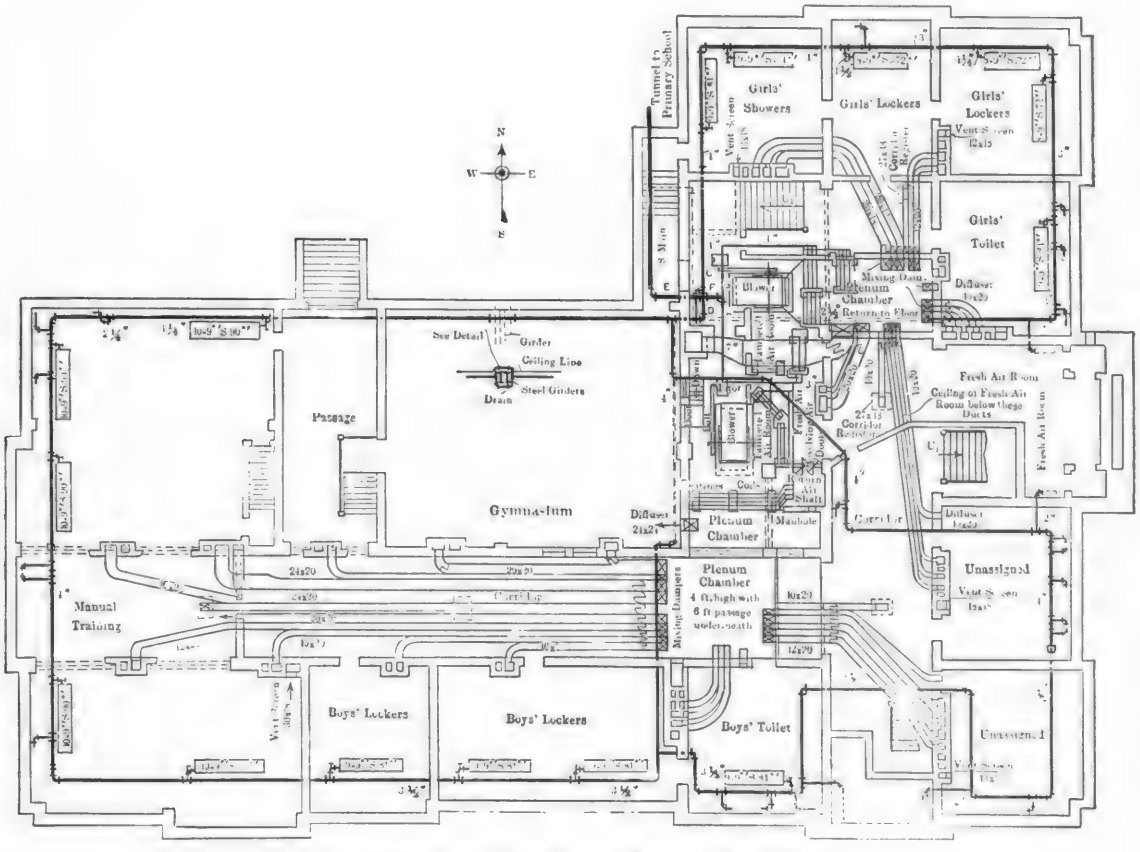
BLOCK PLAN OF SCHOOL BUILDINGS AND POWER HOUSE

type of plant is not adapted to economical operation from a central city plant, because it is not operated twenty-four hours per day, as residences, stores, etc., heated by direct radiation would be, but, on the contrary, is in use, with the fan running, only from six to ten hours per day for five days per week.

On account of cooling off every night, the demand for steam on cold mornings was therefore enormous, and to supply it at two pounds pressure often necessitated a back pressure of from six to ten pounds on the large engines in the power house. The fan motor was on the railway circuit, and would cut out whenever the current weakened, necessitating constant attention by the janitor. Thus neither the school district nor the railway and light company were satisfied with the conditions. In the meantime the high school was in process of erection, and it developed that the boilers in the grade school, which is an old building, were worn out. Therefore the school district decided to furnish its own steam, power and lights. The basements of the buildings were required for other purposes, so a separate boiler house was decided upon.

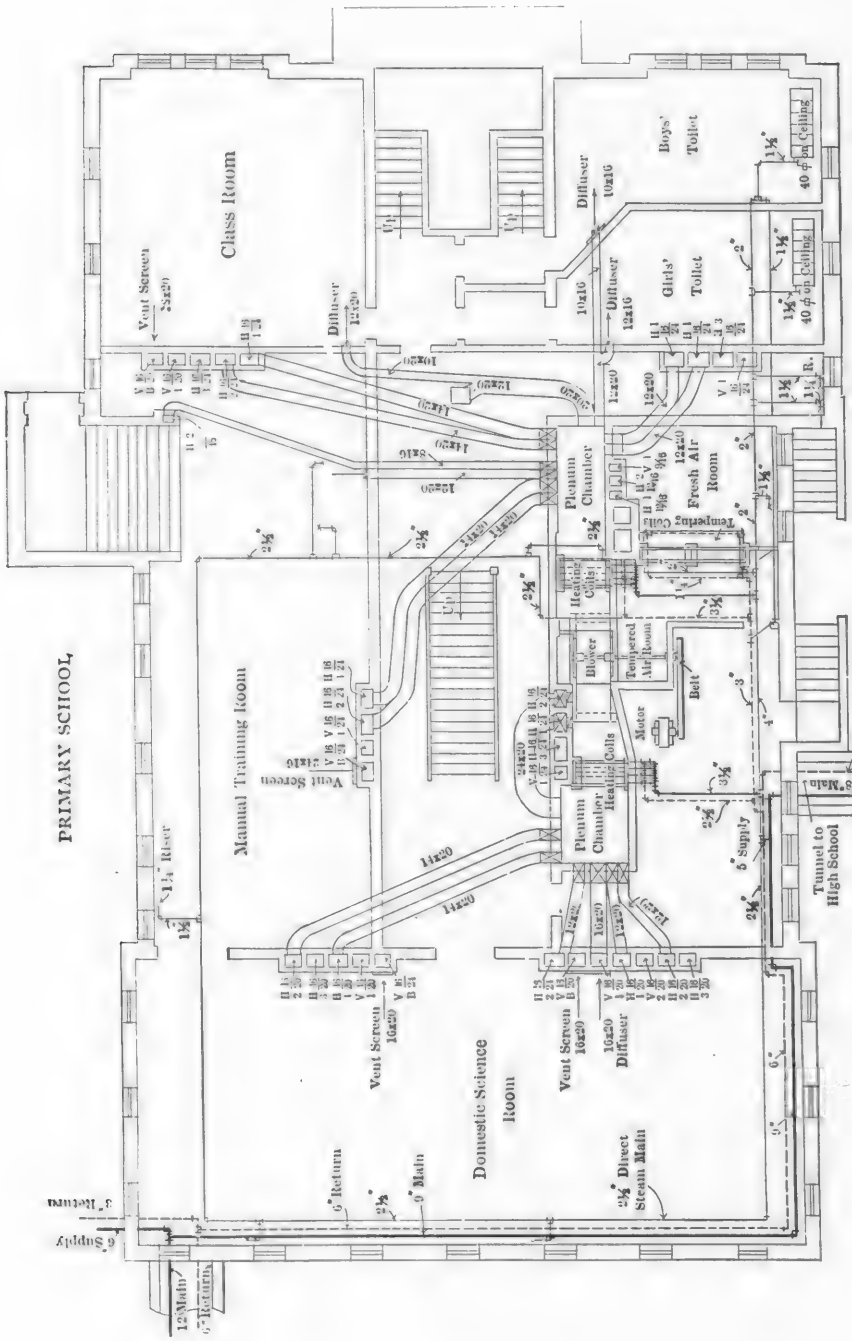
HOT BLAST SYSTEM.

The blast steam method of heating and ventilation was adopted for the high school, the type of plant being similar to that in the primary school. The basement plans of both buildings are shown. The air is drawn through

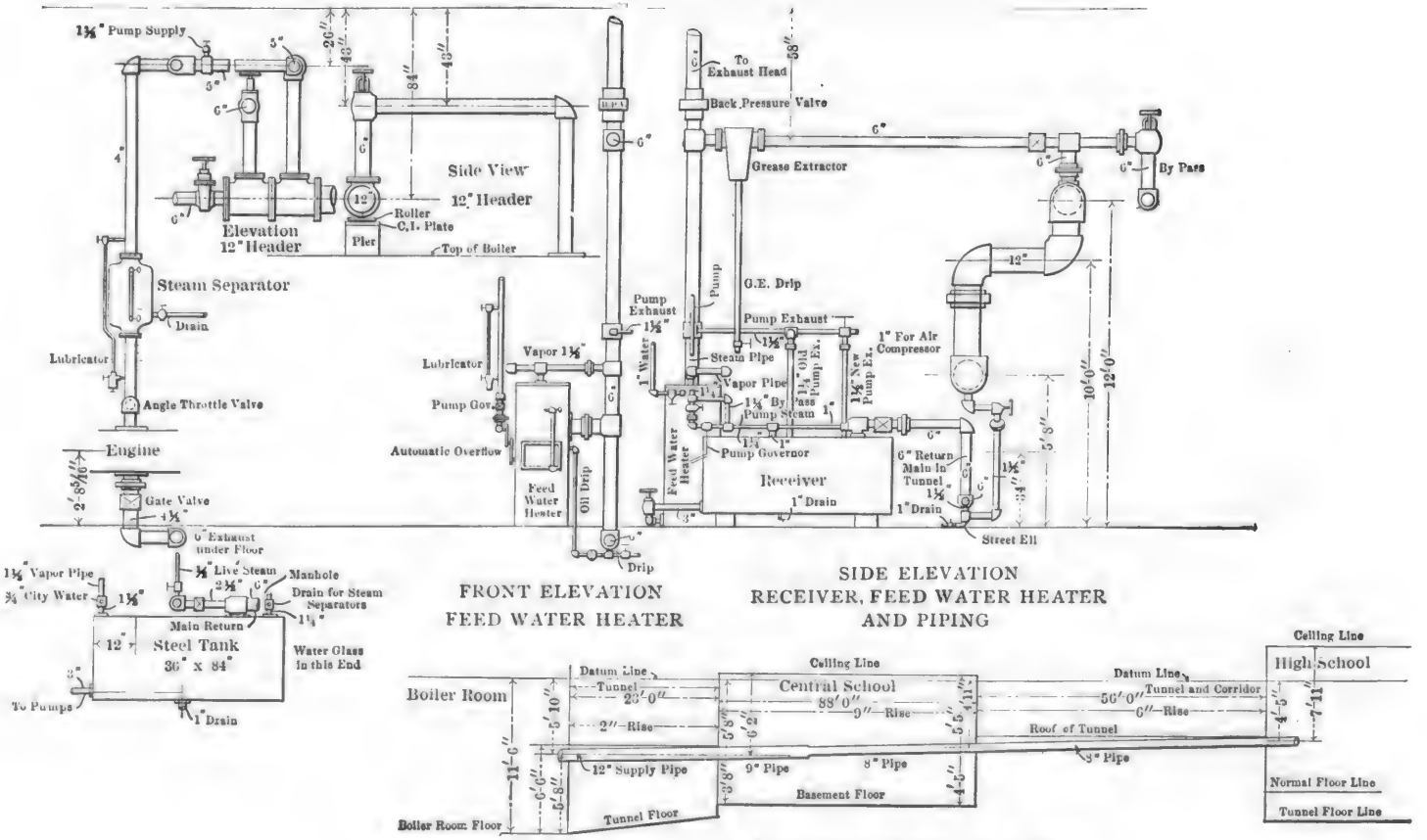


BASEMENT PLAN OF HIGH SCHOOL BUILDING

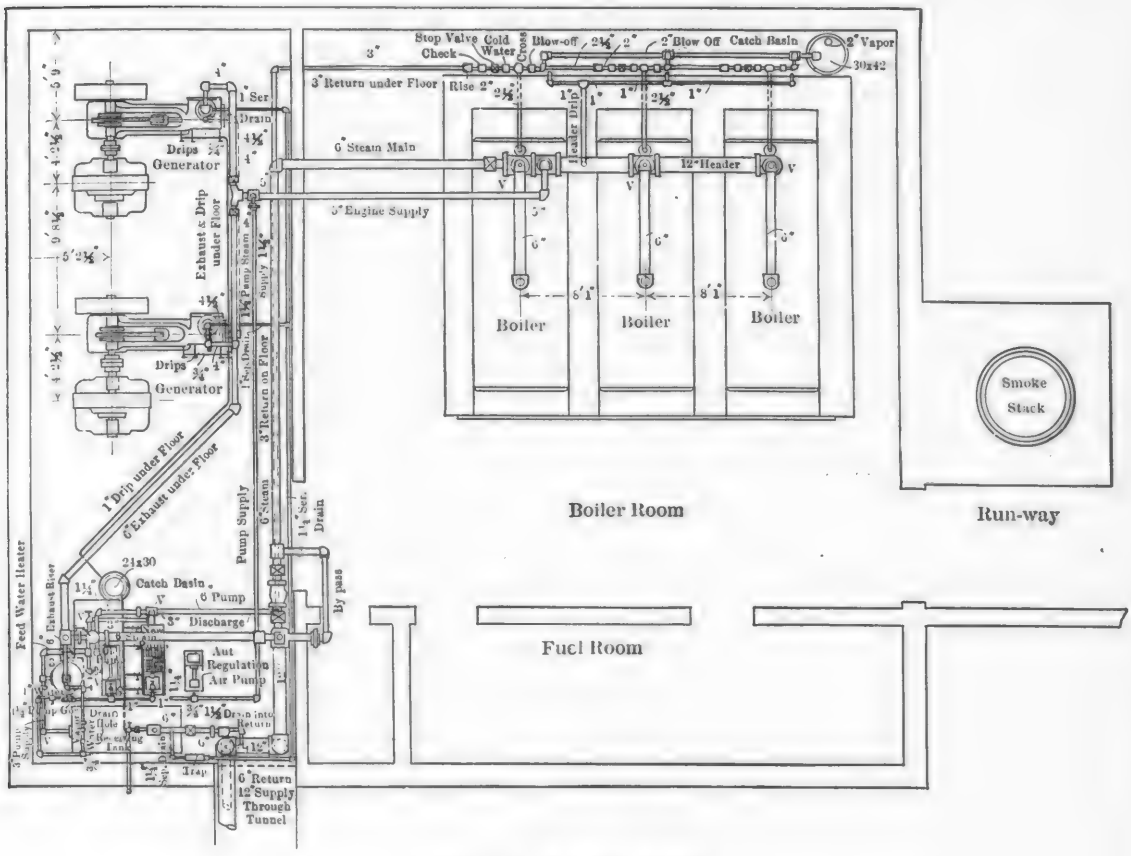
tempering coils to the fans, which discharge through heating coils and bypasses to plenum chambers. These chambers are each divided into two horizontal compartments: one containing tempered air at about 60° F., the other containing heated air at about 130° F.



BASEMENT PLAN OF PRIMARY SCHOOL BUILDING



DETAILS OF CONNECTIONS TO AUXILIARY APPARATUS IN BOILER HOUSE



PLAN OF BOILER HOUSE

From these chambers single sheet metal ducts lead to vertical flues, which supply the various rooms and departments. The single ducts each have double dampers in the connections to them from the plenum chambers, so that air at varying temperature but constant volume may be admitted. The flues discharge through adjustable diffusers at a distance above the floors of the rooms of about two-thirds of the height of the same. The ventilating grills are at the floor line on the same side of each room as the inlet openings. The ventilating flues are connected in the attic with sheet metal ducts, leading to ventilators in the roof. They also connect with vertical shafts leading back to the fans, so that the air in the buildings may be rotated.

The temperature of the rooms and tempered air plenum chambers is automatically controlled. The dampers in the roof ventilators and return air shafts are controlled from the basement by compressed air. Direct radiation is installed in toilet rooms and corridors, and auxiliary direct radiation is placed in such other rooms as have plumbing apparatus, or which might be used by a small number of persons on holidays or at night, when the fans would not be in operation.

Considerable study was required to install the apparatus in the space assigned, without having any great lack of symmetry in the air distribution, and it appears cramped on the plans, but there is ample room for attention and inspection, and there has been no trouble in warming the buildings or in equalizing the air delivery.

Because of a large assembly room, seating over 500 persons, in the high school, often used for entertainments, one of the fans is arranged to serve that room alone when desired. The assembly air inlets are 16 feet above the floor on the dead side of the room,

which has three sides exposed, and is 100 feet long. The ventilation is distributed, and 320 square feet of auxiliary direct radiation is placed in the far end.

The fans are designed to furnish a minimum of 30 cubic feet of air per occupant per minute, at not to exceed ½ ounce pressure at the fans, at the same time furnishing sufficient air to change the volume in corridors, cloak rooms, etc., once every ten minutes. The ducts are calculated in general for a maximum velocity of not more than 800 linear feet per minute, and the flues for a maximum of not exceeding 600 linear feet per minute.

EQUIPMENT OF BUILDINGS.

A velocity of 1,100 feet per minute is allowed through the blast coils. The grade school, outline plans of which are shown, contains old style direct radiation on the two pipe system, with gravity air supply warmed by cast iron indirect radiation. It will eventually be changed, in all probability, to a blast system similar to that in the other two buildings. The equipment of the three buildings is as follows:

Building.	Cu. ft. contents	Cu. ft. air per minute	Sq. ft. blast radiat'n	Sq. ft. direct radiat'n	Sq. ft. indirect radiat'n	Size blowers	Size motors
High School.....	682,540	65,000	5,185	3,500	.....	1–8′ 6″ 1–8′ 0″	2–15 H.P.
Primary.....	237,600	21,500	1,893	600	.....	1–6′ 0″	1–7½ H.P.
Grade.....	276,558	.....	.....	3,250	1,200	.....	.....
Totals.....	1,196,698	86,500	7,078	7,350	1,200		

In addition there is required about 15 horsepower for motors in the manual training department and about 900 16 C. P. lights.

The condensation in the blast coils was assumed at one pound of steam per square foot per hour, as they were 20 rows of pipe deep. Three-tenths of a pound of steam condensed per hour per square foot was allowed for the direct radiation. This has been found to carry sufficient capacity for mains of reasonable length. On this basis 330 boiler horsepower would be required, and boilers of 375 commercially rated horsepower were installed. The boilers have carried the load with ease.

DESCRIPTION OF POWER HOUSE.

As shown on the plan, the boiler house is directly behind the primary school, and is connected with it by a tunnel. The supply and return mains lead from the primary to the high school basements through a tunnel and to the grade school through a double pine box made water tight. The mains in the box are covered with asbestos one inch thick and packed in mineral wool. The tunnels serve as passageways, and also carry the electric wires.

In the power house there are installed three 72″×16′ 0″ suspended horizontal tubular boilers with standard equipment. They are operated at 90 lbs. pressure. Space is provided for the addition of a fourth boiler, which might be needed should additions be made or steam be supplied to other buildings in the vicinity. There are two 12″×14″ horizontal high-speed automatic engines, two boiler feed pumps and a steam air compressor.

THE STEAM SUPPLY SYSTEM.

Steam is carried from the boilers through 6-inch outlets to a 12-inch header, which is self-draining through separate pipes with valves and checks below the water line of each boiler. The group of buildings is supplied with exhaust steam from the engines, and with auxiliary live steam as necessary through a 6-inch automatic pressure reducing valve. The low pressure steam supply is 12 inches, with an 8-inch branch to the high school, 5 inches to the central school, and 6 inches to the grade school.

The supply mains all pitch up from the boiler house, where they drain into the main return through a 1½-inch relay. While this causes rather slow heating up when steam is first turned on, there has been no trouble on account of expansion or water hammer, though this is the only drain in ordinary use. The expansion is all taken up with swing joints.

The main return is 6 inches, with a 5-inch branch from the high school, 3 inches from the central school and 3 inches from the grade school. The

high pressure piping is all flanged. The engines are provided with steam separators and grease extractors, and exhaust through an open feed water heater into the heating system, or direct to the atmosphere through a back pressure valve. The feed water heater contains the pump governor, which operates either pump, and is in circuit with a large tank which receives the condensation from the heating system. Thus what little fresh water is needed during normal operation is heated and purified before entering the boilers.

As only one boiler would ever be used for running one engine in weather when no heat is required, the feed water heater is of only 150 horsepower. One of the boiler feed pumps is 7″×4½″×7″, of the duplex type. The other is a single acting pump, 6″ ×4″×8″. Preference is given to the latter by the engineer, perhaps because it requires less attention. Duplicate pumps and engines were installed so as to reduce the danger of a shut down during school hours.

The engines are direct connected to two 50 kilowatt 120 volt direct current generators, running at 300 revolutions per minute. A three panel enamelled slate controlling and distributing switchboard is installed. The total load is about 80 kilowatts, but there is slight possibility of more than one-half of this capacity being required at any one time, so that the generators are practically in duplicate.

OPERATION OF PLANT.

The plant has been very satisfactory in operation. The fuel cost for heating, ventilating and lighting the buildings has been $2,066 for the season of 1906-1907. This is at the rate of $1.727 per thousand cubic feet in the buildings per season. There is no connection for power from outside sources, and the above cost includes the lighting and ventilating on many days and evenings when no heat was required, thus involving a higher operating cost than a mere heating equipment would show.

An engineer and one fireman have operated the plant. The expense for attendance has been no greater than it would have been had the janitors of each building handled ordinary systems located therein. The expense to the school district has been at least $1,000 per year less than it would have been had the electricity and steam been purchased.

The gain in space in the buildings, absence of fire in them, elimination of boilers under school rooms, ability to burn cheap fuel economically, absence of dirt and dust—all point to the advantage of a separate power plant under the conditions stated. The mechanical equipment of the high and primary schools and boiler house cost approximately $30,000.

The Combined Pressure and Vacuum System of Steam Heating*

By Geo. D. Hoffman

About five years ago there loomed on the horizon of the heating world a new system of vacuum steam heating, the vacuum being created by the condensation of steam within the apparatus instead of by mechanical means. Since then there has been a strong trend among progressive heating engineers toward this system of combined low pressure and vacuum steam heating in connection with gravity plants, and a number of representative firms are placing on the market special appliances as an aid to the heating contractor in the proper installation of such work.

In view of these facts, it seems preeminently proper and fitting that this system of heating should be investigated by the American Society of Heating and Ventilating Engineers, and its advantages and limitations thoroughly discussed. It is more with this end in view than with any idea of presenting a technical description of this system that this paper is prepared.

PROPERTIES OF A VACUUM.

The term vacuum, according to the dictionary, means an empty space or a

*Paper read at the Semi-Annual Meeting of the American Society of Heating and Ventilating Engineers, Milwaukee, Wis., July 18-19, 1907.

space void of matter, but when the term vacuum is used in connection with a steam apparatus it signifies that means are employed to relieve the apparatus of air or atmospheric pressure, and by preventing its return thus creates a condition under which steam will circulate at temperatures below 212°.

Vacuum can be created in a steam heating apparatus by means of a pump, exhauster or other mechanical device for the removal or exhaustion of air or by the condensation of steam within the apparatus. The method to be described in this paper is the one which creates the vacuum by first filling the entire apparatus with steam, expelling the air through vent ports by pressure, then preventing the return of air by special appliances when the pressure falls below that of the atmosphere.

Many engineers contend, however, that vacuum thus obtained is very much like the proverbial greased pig which was turned loose in barn-raising days, a very slippery customer, but to the man who used plenty of rosin on his hands and trousers the pig was easy; and so it is with the man who uses proper appliances for stopping the two biggest leaks in any apparatus—*i.e.*, the stuffing box of the radiator valves and the venting valves. If he effectually stops these leaks the rest is easy.

ADVANTAGES OF A VACUUM IN AIR-TIGHT SYSTEM.

But, admitting that the heating contractor who has installed such an apparatus has used approved appliances throughout and made it steam, water and air tight, what is the gain? With such an apparatus he can circulate steam throughout the system at temperatures both above and below 212°, and by thus increasing the temperature range within the apparatus he can meet external weather conditions with such an even and equable indoor temperature as will take all the pang out of winter, and do it with a fuel economy that will surprise the uninitiated. Let us study the "why and wherefore."

The atmospheric boiling or vaporizing temperature of water in an open vessel is 212° at the sea level, the boiling temperature falling as the altitude above the sea increases, or as the atmospheric pressure decreases. The boiling point of water under complete vacuum, or complete absence of atmospheric pressure, is 98°, and as water will not boil under atmospheric pressure of 14.7 pounds (sea level pressure) until its temperature reaches 212°, it proves conclusively that it is pressure, and pressure only, that determines the temperature at which water boils. To still further demonstrate this fact, the writer has pumped ten pounds of air pressure on a sealed system and then raised the temperature of the water to 240° before there was the slightest sign of ebullition in the water. On another occasion, with ten pounds pressure on the system, he raised the temperature to 230°, and then extinguished the fire and reduced the pressure by opening a vent cock. As soon as the gauge pressure indicated six pounds, the water began to show signs of life, and when the pressure indicated five pounds it was boiling violently. This is clearly indisputable evidence that it is pressure that governs the temperature of the boiling point of water, and the evidence also clearly proves that the pressure exerted by the atmosphere is constant, aggressively constant, and if not prevented will always determine the boiling point according to its altitude.

But how is vacuum created in a steam heating system without mechanical means?

Steam is water in a gaseous state, occupying a space about seventeen hundred times as great as the water from which it originates; or, in other words, a cubic inch of water when converted into steam, if unconfined, occupies a space equal to about seventeen hundred cubic inches, or about one cubic foot.

When the conversion of water into steam takes place within an enclosed space, for instance, a steam heating apparatus, if the different parts of the apparatus are properly proportioned, the steam would fill the space in the apparatus not occupied by water

were it not for the fact that this apparently unoccupied space is in reality fully occupied by air.

Steam and air, being of different density, will not mix, and the result is when steam is generated there is simply a pushing or compressing of the air into the pipes and radiators as the steam pressure increases. In order to allow the steam to circulate into and through all the pipes and radiators, it is therefore absolutely necessary to provide an outlet for the air, or what is commonly called an air valve or vent, on each and every radiator or heating coil connected with the boiler. When the air has been entirely expelled from the apparatus by pressure of steam, the apparatus may be said to be full of steam.

Since steam occupies a space about seventeen hundred times greater than the water from which it generates, it follows, as a natural sequence, that the water from which the steam originated occupies a space seventeen hundred times less than the steam; hence, when the steam is again condensed to water, the space occupied by the steam will be left a void or vacuum, provided the air is prevented from returning into this space. If the condensation of steam or water were instantaneous, there would be little to recommend the vacuum system of steam heating on gravity plants; but the fact is that the condensation and loss of heat is gradual, and can be checked and held, provided there are no air leaks in the apparatus at any point between atmospheric pressure with a temperature of 212° and an absolute vacuum with a temperature of 98°, by simply increasing the strength of the fire to a point where the heat units delivered by the fire equals the heat loss from the apparatus. The various degrees of vacuum and pressure and the corresponding boiling temperature of water between 29.92 inches of vacuum and 10 pounds pressure are shown in the following table:

Vacuum Gauge, Inches of Vacuum.	Temp. of Steam or Boiling Point of Water.
29.92 inches	98° F.
29 "	100° "
28 "	102° "
27 inches	114° F.
26 "	125° "
25 "	133° "
24 "	140° "
23 "	146° "
22 "	152° "
21 "	157° "
20 "	161° "
19 "	165° "
18 "	169° "
17 "	172° "
16 "	175° "
15 "	178° "
14 "	181° "
13 "	184° "
12 "	186° "
11 "	188° "
10 "	191° "
9 "	194° "
8 "	196° "
7 "	199° "
6 "	201° "
5 "	203° "
4 "	205° "
3 "	207° "
2 "	208° "
1 "	210° "
0 (atmosphere)	212° "
Steam gauge Pounds pressure	
1 pound	215° "
2 "	219° "
3 "	222° "
4 "	225° "
5 "	227° "
6 "	230° "
7 "	232° "
8 "	235° "
9 "	237° "
10 "	240° "

It is apparent from a study of the above tables that if any particular pressure either above or below atmosphere is maintained in a steam heating apparatus that steam at the temperature corresponding to that particular pressure can be circulated throughout the entire apparatus, provided the same is absolutely air tight and all air has been previously expelled from the apparatus.

EFFECT OF AIR IN HEATING SYSTEMS.

It is also apparent from a study of the above table that air is the great enemy to be contended with in connection with this particular system of heating. When operating a plant below atmospheric pressure, air exerts a constant, steady pressure (equal to one-half pound for every inch of vacuum indicated) on every part of the apparatus, including radiators, pipes, fittings, boiler and boiler trimmings both above and below the waterline in the boiler. Give it the slightest

chance, even to the extent of a pinhole in the left-hand lower corner of the boiler, and air will force its way into the apparatus and eventually kill the steam and steal whatever heat is in the radiators. Air, when it once gets a foothold, holds its position until it is driven out by force, that force in the system under discussion being steam pressure.

It is plainly evident from the foregoing that if it wasn't for air in the system, steam or vapor would begin to circulate through the radiators at 96°, and every degree of heat added to the water in the boiler would mean an added degree to the heat in the radiators. If it wasn't for the air in the system it would be possible to have a range of temperature within the apparatus of from 98° (the boiling or vaporizing temperature of water under vacuum) to 240°, the temperature under ten pounds pressure.

Admitting this to be a fact, it is only logical to presume that any method of installation which would have for its object keeping the air out of an apparatus after it is once gotten out, would be worthy of serious consideration.

FACTOR OF WASTE IN HEATING SYSTEMS

There are always two factors of waste in any steam heating apparatus, or, in fact, in any heating apparatus; first, overheating of the room beyond the temperature required for comfort; and, second, the chimney waste, and the elimination of these wastes or their curtailment means fuel economy, and this is the goal sought by all systems. Keeping the air out by other means than the pressure of steam is surely an economy of heat energy and a step in the right direction.

While it is an admitted fact that it is a physical impossibility to so construct a steam heating apparatus as to make it absolutely air tight against vacuum pressure, still it is possible to so construct and install a combined pressure and vacuum system of steam heating as to insure for limited periods of time a temperature range within the apparatus of 75° to 100° (from 140° to 240°). This flexibility of control gives the intelligent operator the means of properly utilizing the fuel used with a minimum waste. It is evident that it cannot acquire as much fuel to heat water to a temperature of 160° F. as it would be to heat it to 212°.

If, therefore, the outside temperature only required an inside radiator temperature of 160° to maintain the desired heat in the building, it follows that a smaller amount of fuel can be used, provided steam can be generated and circulated at 160°.

HEATING TESTS UNDER PRESSURE AND UNDER A VACUUM.

In order to be able to present some accurate data on the question of fuel economy in connection with this system of heating, the writer installed a small plant of four radiators in which gas was used as a fuel. The accompanying table shows the consumption of gas per hour under pressure and vacuum, the temperature of the room in which the radiators were placed being maintained at 70° during the test:

TABLE SHOWING CONSUMPTION OF GAS PER HOUR UNDER PRESSURE AND VACUUM

To maintain a steam temperature of	Required the consumption of	The gauge registering
212°	60 feet gas per hour	—atmosphere
201°	50 " " " "	6 in. vacuum
190°	39 " " " "	10½ "
180°	29½ " " " "	14½ "
172°	27½ " " " "	17 "
157°	24 " " " "	21 "

In the above test, when the outside temperature was sufficiently cold to demand 212° of steam heat in the radiators it required 60 feet of gas per hour to maintain this temperature, but as the outside temperature moderated a corresponding lower temperature of steam (calling for a less consumption of gas) was required in the radiators, until it reached a point when only 157° of steam and a gas consumption of 24 feet per hour was required to maintain the room temperature at 70°. An-

other test was made (at a time when only 157° of steam was really required to maintain the room temperature at 70°) of consuming 60 feet of gas per hour and maintaining a steam temperature in the radiators of 212°, with the result of raising the room temperature to 85°. The 15° surplus heat was thus maintained at a cost of 26 feet of gas, and, as the 15° of heat was not needed, the fuel or gas thus used unnecessarily was wasted. With the ordinary steam job it is necessary to have 212° of steam heat in the radiators in order to have any heat at all, and the resultant economy, as shown in the above table under different temperatures of steam, is an example of the economy to be derived from the use of this combined pressure and vacuum system of steam heating. In the hands of an intelligent operator, provided the system is reasonably tight, it is possible to practically do away with the overheating evil attending the use of the ordinary steam apparatus by enabling the operator to circulate just the required degree of steam throughout the apparatus necessary to maintain the desired temperature in the heated room.

Hold fast to that which is good is a trite saying, but also an axiomatic truth. To hold steam even at a lower temperature than 212° in the radiator on a cold winter's night is surely holding a good thing, and it is also surely a common-sense proposition to keep air out of an apparatus as long as possible, after it has been once gotten out by the expenditure of fuel energy. The advocates of the combined pressure and vacuum system of steam heating claim that the advantages over the ordinary system of steam heating are:

1.—A range of temperature from 140° to 240° within the apparatus to suit any external temperature.

2.—Economy in fuel. During the ordinary weather the fire can be banked for hours and still a sufficient heat circulated through the radiators to maintain the temperature in the living rooms at the proper degree.

3.—Economy and labor, as less fuel is consumed and less labor is necessarily expended in the care of the apparatus.

4.—The great physical comfort of the inmates of a building so heated, because of the fact, if properly controlled, the heat is always just right, no matter what the outside temperature may be.

1.—The advantages of this system of heating over hot-water heating are low cost of installation, the cost of installing a vacuum system of combined pressure and vacuum heating being but little more than the ordinary steam system, and therefore very much less than hot water.

2.—Economy in fuel. With a hot-water apparatus a quantity of water is required to fill the entire system, boiler, pipes, radiators, etc., being at least twenty times as much as required in the vacuum system of steam heating. In a vacuum system of steam heating it is steam circulating through the pipes and radiators which carries and distributes the heat of the fire to the various parts of the building, while in a hot-air apparatus it is the water itself which carries and distributes the heat. The velocity of the water travel is comparatively slow, while steam travel, especially in vacuum, is almost as rapid as thought itself. The quickness of results, or what might be termed the flexibility of a vacuum system of steam heating, enables the operator at all times to have just the right amount of heat in the radiators to maintain the desired temperature, and thus prevent the waste of fuel incidental to overheating.

3.—Economy in space required for the radiators. As a much higher temperature can be maintained in the radiators in a combined pressure and vacuum system than in hot-water radiators, it is evident that less radiation and therefore less space is required.

4.—All danger from leaks in the combined pressure and vacuum system of steam heating is practically done away with.

Another great advantage of the combined pressure and vacuum system of steam heating is the fact that by use of the approved appliances now on the market this system can be easily installed on any system of low-pressure steam heating, old or new.

THE HEATING AND VENTILATING MAGAZINE

PUBLISHED MONTHLY AT
1123 BROADWAY, NEW YORK
BY THE
HEATING AND VENTILATING MAGAZINE CO.

A. S. ARMAGNAC, EDITOR

European Representative:
AMERICAN PUBLICATION BUREAU, 31, Overton Road, Leicester, England

Subscription, - - - - - $1.00 per year
Foreign countries, - - - - 1.50 " "

Manuscripts submitted for publication must in every case be accompanied by postage; otherwise they will not be returned.

AMERICAN heating engineers, to whom foreign technical articles are usually more interesting than useful, will find some noteworthy exceptions in the papers provided for the summer meeting of the British Institution of Heating and Ventilating Engineers held at Windsor, England, June 25 last. The two papers on the programme bearing directly on the subject of heating and ventilating are eminently practical and, as far as their interest to those in this country is concerned, they might easily have come from the pens of American writers. Indeed, in the description of the plant for the Budapest Stock Exchange, which was the subject treated at the meeting by Charles Knuth, Jr., a discussion of pipe sizes for low pressure steam heating, which was included, was intended to be supplementary to the discussions on the same subject at recent meetings of the American society. This is very interesting to Americans, both as being virtually a continuation of their own discussions on the subject and as indicating the close relationship that is growing up between the two sister societies.

There is also much food for thought in the paper of Mr. Kenneth Gray on "Capacities of Cast Iron Sectional Boilers." It is apparent that as little satisfaction exists in England as in America over the customary methods of rating these boilers, and Mr. Gray's plan is one that will be endorsed by many American heating engineers.

IN THE programme provided for their summer meeting the American heating engineers have maintained the high standard of their professional papers. Mr. Schlemmer's discussion of his "Formula for Pipe Sizes in Hot Water Heating" is especially timely in connection with the recent report of the committee engaged in collecting data on the subject of hot water heating. Mr. Swan's description of his apparatus for the heating and ventilation of railroad cars will supplement the paper of Professor R. C. Carpenter read at the previous meeting, describing various methods of heating railway cars. In his paper on "The Combined Pressure and Vacuum System of Steam Heating" Mr. George D. Hoffman elucidates in an interesting manner the action of steam under pressure and under a vacuum, showing the permanency of the use of vacuum systems in steam heating. In the line of completed heating and ventilating installations, Mr. Lewis's paper illustrating the mechanical plant for a group of school buildings in Galesburg, Illinois, has many features of interest which make it worthy of a place in a heating engineer's reference files. Professor J. D. Hoffman's paper on "The Design of a Plenum System for a School or Office Building" is a successful and well-prepared attempt to work through the important parts of the design of such a system for a typi-

cal two-story and basement office and school building.

THE reports received of the recent annual meeting of the National Association of Master Plumbers, at Louisville, indicate that the question of the replacement of defective parts by manufacturers, which has been vexing that association as well as the master steam fitters, is as little likely of a settlement favorable to the master plumbers as it is of one favorable to the master steam fitters. Either the difficulties in the case are greater with the plumber or the matter is viewed in a much different light, for while the master steam fitters, in convention assembled, officially favored the rubber stamp making the replacement of defective parts a condition of their orders, the master plumbers, under the guidance of those who are described as its oldest and most conservative leaders, and after an active debate on the subject, voted to refer the stamped order question to the incoming board of directors. In view of the debate preceding the adoption of this motion, the action of the convention will be generally understood as disposing of the matter, at least for the present, by laying it "on the table."

THE lack of progress made by standardization committees of several important trade organizations calls attention anew to the fact that the manufacturing world is growing farther away each year from the influences that are seeking to secure its cooperation. This does not indicate an unwillingness on the part of the manufacturers, except on the ground of expense. It has been shown that if the recommendation of one committee alone were accepted by the manufacturers it would involve an expenditure in some cases of upwards of $100,000 for new patterns, etc. That the difficulties will increase rather than grow less as time goes on goes without saying, all of which indicates the urgency of prompt action unless the fruits of the efforts already expended are to be lost. The master steam fitters are now engaged in an effort to standardize pipe, valves and other materials used by them. The master plumbers are at work upon a standard thread for basin, bath and ball cocks, while an effort to standardize brass tubular goods is being made by the National Association of Brass Manufacturers. These are all worthy objects, and if found feasible they should enlist the support of every user, as well as the makers, of these goods.

OWING to our crowded reading columns, the second portion of Mr. Carrier's interesting paper on the subject of the cooling and humidifying of textile mills will appear in the August issue, instead of this month, as announced.

THE old-time ventilator funnel, which has been so distinctive a part of the equipment of the larger steam vessels, is one of the methods of ventilation that has most recently begun to give way to more positive means, being gradually supplanted by the more compact and adaptable fan blower. A notable installation was recently made on the newly-completed battleship "New Hampshire," which included 25 electrically driven fans of various types and sizes. These fans are scattered all over the ship and are applied for boiler and engine room ventilation, as well as for renewing the air in cabins, mess-rooms and holds. For fire-room service the motors for fans are enclosed to prevent damage from dust in the air.

CORRESPONDENCE

On the Wastes of Heating

Editor HEATING AND VENTILATING MAGAZINE:

There is little accessible data on which to base an estimate of the average losses in heating. Probably it will range between 50 per cent. and 75 per cent. Of course, the wastes vary greatly under various conditions. Uneconomic and avoidable waste will generally be considered to be lamentable by most persons. The bloated bond-holder who has his open cannel coal fire and who has his elaborate expensively installed heating system does not look at it in that way; neither does the individual who is fortunate enough to have an unlimited wood supply, and who can afford the healthful luxury of an open wood fire. But to the average individual, the cost of keeping comfortable through the art of heating is a serious matter.

In order that an intelligent remedy may be devised and applied for any ill, one must have an intelligent appreciation of the causes of that ill. Now the causes of wastes in heating are more numerous than anyone would suppose who has not looked into the matter; and some of them have not yet been determined; but these causes are now sufficiently understood to make it apparent that they may be largely obviated.

The greatest and most obvious loss in heating is due to the fact that the heat generated for heating purposes is not used regeneratively, and especially, under conditions which conduce to health. If we heat ourselves by a fire in the open air, we get conditions for health, but the heating thus gained is costly in fuel. On the other hand, if we heat ourselves by a brazier of charcoal in a hermetically sealed apartment, we secure a certain amount of economy in heating, but we run the risk of bringing our existence on this terrestrial ball to an abrupt termination by breathing more CO_2 than is consistent with life.

WASTES IN HOT AIR HEATING.

Some wastes are concomitant with special heating systems. In hot air heating there is a large loss due to the heating of a very large volume of air in order to avoid danger from fire due to using a small quantity of too highly heated air. In such systems a much larger amount of air is introduced into the space heated than is absolutely needed for respiratory purposes. The feeble force of gravity in the travel of heated air, when counteracted by the force of air currents forced through the numerous crevices of a building, is a prominent feature in making this system of heating an uneconomic one.

Much can be done to remedy this condition of affairs by the positive action of a mechanically induced air current in distributing the heat; and we must consider that in the future, the introduction of air warmed to a proper degree will be an approved feature in all heating systems.

The unhygienic features of a direct radiating system without fresh air introduction, will in time become recognized by people of intelligence, and will be prohibited by law. Steam heating as a system is wasteful because all the water in the boiler is maintained at a high temperature; and the heating gases that go through the boiler must of necessity convey away all the heat in those gases of temperatures at and below the temperature of the water in the boiler, and without regard to the volume of heat that passes through the boiler. The waste is less in hot water heating because, with large radiating surfaces, the temperature of the water returned to the boiler is relatively low and hence there is an average lower recipient temperature for the heat in the water of the boiler than in the case of the steam boiler.

IMPROPER ARRANGEMENT OF HEATING SURFACES.

Probably the second great loss in heating is due to the arrangement of the heating surfaces in a manner that prevents the transmission of the heat generated while the gases are passing through the heating passages of the boiler; there not being time enough given to secure the transmission of the heat generated.

The next cause of major importance, and possibly nearly as great as the proceeding named cause, is that due to the loss of carbon monoxide, owing to conditions which are peculiar to the usually negligent management of heating appliances. In a power generator equalization of the rate of combustion is more or less provided for by frequent stoking by hand or by mechanically actuated stoker means. But where there is infrequent charging of fuel, the conditions are present for a very serious loss. In order to secure enough heat all the time during the burning of a charge of fuel in most heaters, more air is allowed to pass through the fuel mass than is actually needed at the beginning of the burning of the newly introduced charge. The result is that more fuel is burned than is necessary immediately after introducing the charge, and the gases are uneconomically air diluted; while further along, when the fuel mass becomes clogged with ashes, there is a loss of un-

combined combustible gases due to the fact that not enough oxygen is brought into intimate union with them, in which case the upper layers of the fuel are simply baked and give off combustible gases which escape uncombined with oxygen.

In large installations where proper stoking management can be given, there may still be a very large loss due to using higher priced fuel than is necessary. This amount of waste may be from 25 per cent. to 50 per cent. in heating.

Among the losses due to imperfection in combustion; besides the escape of carbon monoxide and hydrogen gases, which escape is usually due to lack of over-fire air introduction, there is loss due to the premature absorption of heat from the combining gases, with the consequent reduction of temperature in the gases below that needed for the burning of the gases.

Too intense a rate of combustion with a consequent forming of slag is in some cases an important cause of loss. Incompletely consumed fuel in the shape of cinders, and grate siftings of entirely unburned fuel, may amount to as much as 10 per cent. of the fuel values in exceptional instances. The loss of unburned carbon in smoke is a small one in any instance, although the smoke nuisance may be a serious one. The burning of smoke when produced is practically impossible within the bounds of a reasonable cost. Although a smokeless combustion is entirely possible with the intelligent management of a furnace, the fact remains that the bulk of humanity is not intelligent enough or careful enough to secure exemption from the smoke nuisance in those places where bituminous coal is used. The solution of the smoke nuisance problem lies in the production and distribution of fuel gas, which can be made at a very low cost from any kind of fuel.

In most heating appliances there is a large loss due to unnecessary radiation. There is a very wide variation of losses due to imperfect transmission of the heat generated in heating devices of various kinds. Such losses may vary from 10 per cent. to 60 per cent., and are due to both insufficient area of heating surfaces and also to a defective arrangement of such heating surfaces. This latter defect is so universal in heating appliances, that in all boilers used for heating or power production now on the market there is practically no provision for absorbing large volumes of low degrees of heat, because of an unrecipient water temperature in the boiler.

In some instances, though these are rare, there is quite a loss due to latent heat in steam leakages.

Until one studies the subject, one hardly realizes the loss that is due to air dilution; and especially in those cases in which there is no provision for absorbing the lower average degree of heat in the diluted heating gases. Most heating appliances are so defective in this respect that some manufacturers have deemed it expedient to cut out entirely the over-fire means for air introduction, finding that a better economic result is obtained from a small volume of gas of a very high temperature than from larger volumes of gas of lower temperatures. But this does not obtain in correctly designed boilers. In installations of a certain importance, a considerable saving can be secured by heating air for combustion with what would otherwise be waste heat, especially in connection with the lower degrees of the heat of chimney gases, and with the lower degrees of heat in the water of condensation. Non-regulation of the degree of radiation in harmony with the heating needs is not only a source of pecuniary loss—it affects health and comfort somewhat seriously.

In a succeeding article I will point out the structural defects in heating appliances through which most of these losses are caused, and will point out structural features, the presence of which will obviate in a large degree such losses.

DR. J. M. W. KITCHEN.

Orange, N. J.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

New Members Elected

The following new members were elected through the ballot sent out recently by Secretary Mackay:

MEMBERS

Robert L. Claypool, contracting engineer, Warren Webster & Co., Baltimore, Md.

Jay B. Dill, superintendent and designing engineer, Specialty Mfg. Company, Indianapolis, Ind.

I. H. Francis, Jr., consulting engineer, Commonwealth Trust Building, Philadelphia.

Thomas E. Gildea, heating engineer and contractor, Syracuse, N. Y.

William S. Hemingway, J. L. Mott Iron Works, New York.

James M. Kent, instructor, Manual Training High School, Kansas City, Mo.

Conway Kiewitz, acting chief draftsman, Department of Education, New York City.

William S. Moffett, heating engineer and contractor, Staunton, Va.

Hugh S. Morrison, Morrison Machinery & Supply Company, Richmond, Va.

Everett N. Murphy, Western Kieley Steam Specialty Company, Chicago.

Charles E. Scott, consulting engineer, Bowen Heating Company, Philadelphia.

Louis H. Wheeler, S. N. Wheeler & Sons, Hancock, N. Y.

Edgar C. Wiley, consulting and mechanical engineer, Lynchburg, Va.

ASSOCIATE MEMBERS

A. S. Armagnac, editor of THE HEATING AND VENTILATING MAGAZINE, N. Y.

Harry H. Hess, eastern sales manager for the United States Heater Company, New York City.

Charles A. Smith, architect for Board of Education, Kansas City, Mo.

Winfield S. Fox, superintendent of school buildings, Dayton, Ohio.

John E. Ulrich, assistant in machine design, Purdue University, Lafayette, Ind.

Miner D. Woodling, erecting and testing engines, with Lewis & Kitchen, Kansas City, Mo.

The British Institution of Heating and Ventilating Engineers

The summer meeting of the Institution of Heating and Ventilating Engineers was held at the White Hart Hotel, Windsor, England, Tuesday, June 25 last. The following papers were read and discussed: "The Heating of the Stock Exchange at Budapest," by C. Knuth, Jr.; "Boiler Capacities of Cast-Iron Sectional Boilers," by Kenneth Gray; "Some Hints on the Preparation of a Paper and Its Illustration," by W. A. Young.

A delightful programme of entertainment was carried out, including a steam launch trip to Henley.

National Association of Manufacturers

President James W. Van Cleave was re-elected president of the National Association of Manufacturers at its recent convention at New York, May 20-23 last. President Van Cleave in his annual address appealed to the association to furnish him with a fund of $500,000 a year, for three years, to be used "to federate the employing classes of the country into a solid mass" in the work for industrial peace. Among those appointed on a special committee of the council to act with himself in devising a plan for raising the fund is George T. Coppins, of the Walworth Mfg. Co., Boston, Mass. Mr. Coppins was also elected as one of the vice-presidents of the association.

The system by which the Pabst Theater, in Milwaukee, is cooled during warm weather is noteworthy. Motors operated in the dome of the auditorium force a continuous stream of air over cakes of ice down through flues in the walls and thence into the body of the house through numerous ventilators in the walls and under the seats.

The Cooling Process

The process of cooling is essentially the reverse of that employed in heating, but systems which materially lower the temperature of the admitted air require the most careful attention in the matter of distribution and maintenance. Many combined systems of ventilation and cooling contemplate only a rapid passage of outdoor air through the apartment requiring reduction in temperature. Perceptible air movement has the effect of cooling even with no material change in temperature. The rate of change may be as frequent as once in two minutes in the case of an overheated engine or boiler room.

Local ventilation and cooling is best secured by the use of an exhaust fan and the proper hooding of the source of offence, but such an arrangement is generally impracticable, and a general sweep of air through the room must be substituted. Closely allied with the cooling process is the prevention or removal of visible moisture in the form of steam. In the paper mill machine room, with its numerous heated cylinders surrounded by moist paper, a perfect system of prevention and cure includes a hot blast apparatus by means of which heated air is forced into the room and an exhaust fan with hood connection by which the heat and moisture just above the machine is directly and positively removed. The warm air supply to the room absorbs the moisture not directly removed by the exhaust fan and prevents deposition of moisture.

In the dyehouse the offence of steam production is greatest and a complete application most essential. The slasher room of the modern cotton mill provided with a locally applied exhausting system is kept perfectly clear of steam in distinct contrast to the older form of construction with so-called natural ventilation.

A Novel Conception of the Sun

In discussing the laws of radiation before the New York Section of the Illuminating Engineering Society, March 22 last, the speaker, Professor O. Lummer, of the University of Breslau, Germany, said that one of the results that has come about from the study of radiation is a change in our conception of the sun. Observations of the sun, he said, seem to show a solid or liquid body surrounded by incandescent vapors. This it is now thought is an optical illusion; there is no sharp dividing line; in fact, there can be no such line under the conditions existing in the sun. The sun itself must consist of an incandescent mass, densest at the centre, decreasing in density as the distance from the centre increases, and finally fading away; in fact, it is possible that the sun itself really reaches to the earth.

TRADE AND MISCELLANEOUS NOTES

Deaths

John A. Walker, vice-president and treasurer of the Joseph Dixon Crucible Co., Jersey City, N. J., died at his home in that city May 23. He was 70 years old. The two offices left vacant by his death have been filled by the election of George T. Smith as vice-president and George E. Long as treasurer. Harry Dailey has been elected secretary and director.

Miscellaneous Notes

International Heater Co., Utica, N. Y., has appointed Frank T. Bassett, Jr., superintendent of sales at the home office, vice Thomas E. Crone, resigned. Mr. Bassett was formerly Boston manager for the American Radiator Company.

National Regulator Co., Chicago, Ill., manufacturer of heat-regulating devices, announces the appointment of John F. Carney as manager of its New York branch at 1133 Broadway. Mr. Carney was formerly connected with the McCrum-Howell Company and for the past year has been manager of the heating department of the Barstow Stove Co., Providence, R. I.

Edward P. Bates, Syracuse, N. Y., accompanied by his wife, attended the Naval Architects' International Congress at Bordeaux, France, which was held June 25-29 last. Mr. Bates was a delegate to the congress from the Society of Naval Architects and Marine Engineers.

E. J. Harrington, Fargo, N. D., is building a two-story addition to his heating and plumbing plant 24x40 feet, which will make his equipment one of the largest of its kind in that section of the West.

Lorain Heating & Supply Co., Lorain, Ohio, through C. E. Van Deusen, its assignee, has sold its stock and fixtures to John F. Williams, of Sandusky. The business will be removed to Sandusky.

Hutchinson, Kan.—The heating plant for the new Harvey House, being built by the Santa Fé Company, will be located in the freight house west of Main street, 1,000 feet away from the hotel building. The plant will furnish heat to the freight, passenger and hotel buildings.

Utica Drop Forge & Tool Company, Utica, N. Y., suffered a loss of $200,000 June 25 last in the destruction by fire of its plant at Utica.

Herbert A. Joslin has associated himself with the Consolidated Engineering Co. of Chicago, Ill., and has been made New York manager of the company with offices at 1211 and 1212 Presbyterian Building, 156 Fifth avenue, the telephone number being 1266 Gramercy. Mr. Joslin's long experience in connection with the use and sale of heat controlling apparatus renders his new connection an important one to the trade.

Detroit Salesmen's Club is the name of an organization formed June 17 last by a number of the steam fitting and plumbing supply salesmen in Detroit to promote social and commercial intercourse. The following officers have been elected: President, Guy L. Pixley; secretary and treasurer, Harry W. Taylor; directors: D. A. Patherick, E. J. Kline, E. A. Pinchin, Harry W. Taylor and Guy L. Pixley. It is proposed later to have permanent quarters for the club.

Westinghouse Electric & Manufacturing Co., Pittsburg, Pa., will add a new department to its East Pittsburg plant, devoted to the manufacture of electric

CLASS A RETURN TRAP

THE ALBANY RETURN STEAM TRAPS

Have been the standard for over thirty-two years. For returning water under pressure to the boiler they will perform this duty fully as well and in many cases better than the so-called steam loop.

SEND FOR CIRCULARS A. B. C. AND D.

CLASS D TRAP HIGH PRESSURE

MANUFACTURED BY

ALBANY STEAM TRAP CO., ALBANY, N. Y.

ESTABLISHED 1870

JAMES H. BLESSING, Pres. THOMAS F. RYAN, Treas

heating apparatus. This company has recently taken over the business of the Hadaway Electric Heating and Engineering Company of New York. The new department will be in charge of Mr. Hadaway.

Pittsburg Water Heater Co., Pittsburg, Pa., has taken over the business and plant of the Monarch Water Heater Company and will continue the business of that firm in the manufacture of automatic water heaters. The new firm's address is 1302-1342 River avenue, North Side. R. C. Frampton is president and general manager.

Central Heating Co., Milwaukee, Wis., has increased its capital stock from $25,000 to $1,000,000.

Union Steam Pump Co., Battle Creek, Mich., has drawn plans for the entire reconstruction of its present plant and for an additional building which will increase the floor space of the plant to about four acres. The company's business for the present year shows an increase of 50% over that for the same period last year.

Oster Manufacturing Co., Cleveland, Ohio, is building a new machine shop 146x40 feet and two stories high.

New Incorporations

Vulite Boiler Fluid Co., Boston, Mass. Incorporators: James R. Murphy, D. T. McIsaac and Parker D. Morris. Capital, $3,000.

De Lany Separator Co., New York, to manufacture separators, machinery, etc. Capital, $100,000. Incorporators: Richard F. George and Byron W. Holt, both of New York, and Robert Baker, Brooklyn.

American Submerged Exhaust Co., New York, to take over business of the Goodwin Submerged Exhaust Co. Capital, $20,000. Incorporators: H. Russel Perkins, Moses Brown and Jacob H. Bartlett. The Goodwin plant will be enlarged.

K. J. Brown Co., Akron, Ohio, to conduct a heating and plumbing business. Capital, $15,000.

P. J. Glennon Plumbing Co., Seattle, Wash. Capital, $10,000. Incorporators: P. J. Glennon, A. E. Pepper and E. F. Greene.

Cooper Heater Co., Dayton, Ohio, to manufacture hot-water heaters. Capital, $100,000. Incorporators: Edward Martin, J. D. Hunter, W. L. Blackwell, William J. Cooper and F. R. Martin.

M. T. Davidson Co., Brooklyn, N. Y., to manufacture steam pumps and hydraulic machinery. Capital, $400,000. Incorporators: Marshall T. Davidson, William C. Newell, John Lowe and William A. Drewett, all of Brooklyn, and Oran Baldwin, New York.

W. H. Swanson Co., Fostoria, Ohio, to take over business of W. H. Swanson. Capital, $10,000.

Kearney Heating and Plumbing Co., Hattiesburg, Miss. Capital, $10.000. President, M. T. Epley; vice-president, R. S. Hall; secretary and treasurer, J. S. Kearney.

Metropolitan Plumbing Inspection Co., New York. Capital, $20,000. Directors: C. E. Goodrich, Brooklyn; G. W. Schodde and Lawrence Roth, New York.

Leonard G. Kirk Co., New York, incorporated at $10,000 to conduct a steam and hot-water heating business. Incorporators: Leonard G. Kirk and Walter Bimpson, of New York, and E. R. Kirk, of Clifton Park, N. J.

Camden Heating and Plumbing Supply Co., Camden, N. J. Capital, $150,000.

PLUMBING AND HEATING BUYERS' DIRECTORY

UNITED STATES AND CANADA

Most Complete, Up-to-Date Directory of MASTER PLUMBERS and STEAM FITTERS, with CAPITAL used in business.

Trade Names, Closets, Bath Tubs, House Heating Boilers, Radiators, Lavatories, etc.

All goods classified with names of Manufacturers and Jobbers. Full of business information.

NOW READY. PRICE, $5.00

PLUMBING & HEATING PUBLISHING CO., Publishers

150 NASSAU STREET, NEW YORK

Incorporators: F. H. Burdsall, J. W. Morgan and L. B. Reader, all of Camden.

Camden Heating, Ventilating and Power Construction Co., Camden, N. J., to conduct a plumbing and steam heating business. Capital, $25,000. Incorporators: George F. Kappel, George W. A. Kappel and Edward Bull, all of Camden.

Jefferson Heating Co., Jefferson City, Mo. Capital, $3,000. Incorporators: Ernest Simonson, P. H. Loethen and W. B. Smallman.

Optenberg Iron Works, Sheboygan, Wis., incorporated with a capital stock of $50,000, to take over the business of Optenberg & Sonnemann, manufacturers of boilers and steam-heating apparatus. Incorporators: J. H. Optenberg and William Moeller.

Illinois Heater & Manufacturing Co., Chicago, Ill., incorporated with a capital stock of $20,000, to manufacture heaters and furnaces. Incorporators: Edward R. Litzinger, James McCollam and L. B. Vance. The new corporation will take over the business of the Illinois Heater Company.

Thompson-Miles Co., Pittsburg, Pa., incorporated to deal in heating, hardware and roofing supplies and to carry on a contracting business in connection with these lines. Incorporators: Charles A. Miles, S. M. Thompson and Thomas S. Smith, all of Pittsburg.

John E. Dugan Plumbing Co., Albany, N. Y., succeeding the heating, plumbing and roofing business of John E. Dugan.

Crowe & Balser Co., New Orleans, La., capital, $10,000, to carry on a heating and plumbing business.

Mosher Water Tube Boiler Co., New York, incorporated with a capital stock of $200,000, to manufacture steam heating boilers. Incorporators: John Yard, John E. La Fabregue and Charles E. McCarthy.

Model Plumbing & Heating Co., Beaumont, Texas. Capital $20,000. Incorporators: W. J. Brown, J. N. Flemming, C. A. Crawford, G. W. Carroll, W. W. Weiss and V. Weiss.

Kunze-Manuel Heating Co., Minneapolis, Minn. Capital, $80,000. Incorporators: W. F. Kunze, Leo C. Smith, M. H. Manuel and R. W. Manuel.

John H. Knepper & Sons, Buffalo, N. Y. Capital $25,000. Incorporators: John H. Knepper, Harry J. Knepper and Edward D. Stroebel.

C. S. Teleford Co., Galesburg, Pa., incorporated with a capital stock of $14,000 to conduct a heating and plumbing business. Incorporators: C. S. Teleford, A. N. Teleford and Jennie I. March.

Rolf-Martin Co., Fort Wayne, Ind., incorporated to manufacture water heaters and brass and rubber specialties. Emmet Martin, president; Herman Rolf, secretary and treasurer.

WING'S TURBINE FAN SYSTEM OF MECHANICAL DRAFT

means guaranteed economy of fuel, increased boiler capacity, absolute simplicity.

First and operating costs less than any other system and equals the results of the best.

Requires no floor space and little attention.

Catalogue gives full details.

The Small Fan under the man's arm takes the place of the large blower and engine.

L. J. WING MFG. CO.

West and Cedar Sts.
NEW YORK

Mfrs. Wing's Disc Fans, Blowers and Exhaust Fans

Designers and Builders of Heating and Ventilating Systems

J. C. Moore Hardware & Supply Co., Saltsburg, Pa., incorporated to carry on the heating, plumbing and hardware business of J. C. Moore.

Wheeler - Blaney Co., Kalamazoo, Mich., incorporated to carry on the business of Wheeler & Pitkin, the change being made as the result of the death of Mr. Pitkin. President, John A. Wheeler; secretary and manager, Charles A. Blaney; treasurer, N. B. Wheeler.

J. F. Hanley Company, Newark, N. J., incorporated to take over the business of J. F. Hanley & Co. The company's new address is 231 Ferry street. President and treasurer, James F. Hanley.

Buffalo Pattern Works, Buffalo, N. Y., capital $20,000, to manufacture patterns and models. The incorporators are Edward Simon, Henry Walters, A. W. Plumley and Charles Newton, all of Buffalo.

Fate Vacuum Jacket Co., Portland, Me., capital $100,000, to manufacture heat retaining devices. The officers are J. E. Manter, president; C. D. Fullerton, treasurer, and M. W. Baldwin, secretary, all of Portland.

Sullivan Fuel Economizer Co., New York, capital $125,000, to manufacture fuel saving devices. The incorporators are Morris J. Sullivan, Arthur J. Sullivan, Edward R. Sullivan, all of Mt. Vernon, N. Y.; Daniel J. Mendelson, 120 Liberty street, New York, and Ralph M. Holzman, New York.

General Drop Forge Co., Buffalo, N. Y., capital $100,000. The incorporators are Burt G. Hubbell, Clarence H. Little and John D. Pugh, all of Buffalo.

Republic Heating and Ventilating Co., Jersey City, N. J., capital $100,000. Incorporators: C. N. King, G. W. Russell and J. E. Wooley.

Reliable Plumbing and Heating Co., Champaign, Ill., capital $10,000. Incorporators: Chester D. Brownell, Pearl Fisher and Earle C. Sabin.

Daws Heating and Mfg. Co., St. Louis, Mo., capital $12,000, to manufacture hot water heaters, etc. Among the incorporators are Henry A. Davis, Henry A. Stemmer and Melvin I. Hoffman.

Centralia Iron and Plumbing Co., Centralia, Ill., capital $10,000, to carry on plumbing and steam fitting business; also to engage in manufacture of machinery. The incorporators are H. T. Cunningham, E. B. Condit, James Van Patten and H. S. Cunningham.

Home Plumbing and Heating Co., Topeka, Kan., capital $10,000.

Schneider-Scharff Co., Utica, N. Y., to carry on heating, plumbing and gas fit-

Zinc-Coated Steel Slip Nipples

For Steam and Hot Water Radiators and House Heating Boilers

THE PRATT CHUCK CO., Frankfort, N.Y.

FREE SAMPLES furnished to interested parties

ting business. President, Paul Schneider; secretary and treasurer, Louis Scharff. The other directors are J. Gray Deeke, Albert O. Hesse and J. De P. Lynch.

Higson-Rossiter Co., Salt Lake City, Utah, capital $10,000, to do general plumbing and heating business.

School House Heating in Boston

The fan system of positive heating and ventilation has been extensively introduced in Boston under the following conditions imposed by the schoolhouse commission:

1. Allow about one-quarter foot area cross section of heat ducts for each fourteen occupants.
2. Locate in a corner room within ten feet of outside wall.
3. Locate in a room with one outside wall, fan to be on inside wall near middle.
4. Bottom of opening to be about eight feet above floor.
5. Opening to be one-third larger than area of duct.
6. Opening will be provided with 7/8-inch ground and galvanized steel.
7. Galvanized-iron deflectors to match will be placed in each opening.

This commission has the responsibility of appointing architects and of erecting and furnishing the buildings ready for use. A notable recent example of the work carried out under this condition is the Normal and Girls' Latin Group in which the fan system of heating and ventilation is installed throughout.

Contracts Awarded

A. Jacobs, Detroit, Mich., heating county jail for $2,700.

Otis Engineering Co., Oneonta, N. Y., heating new high school buildings. The contracts amount to $13,600.

Russell-Vail Engineering Co., Fresno, Cal., heating new county almshouse for $3,155.

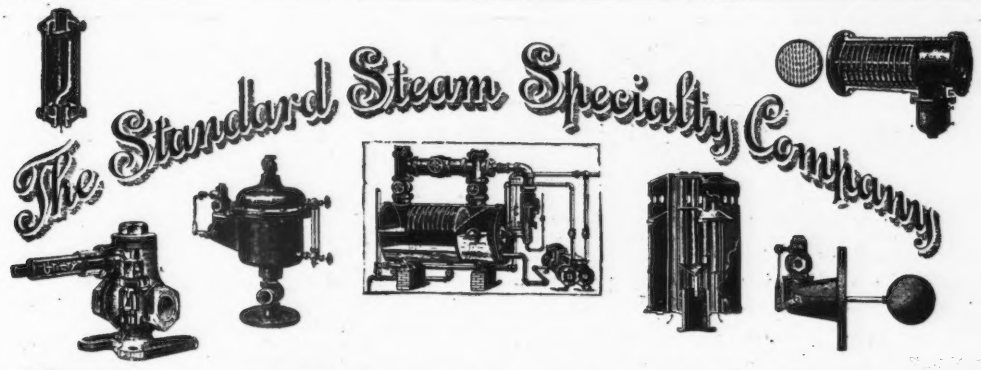
National Plumbing and Heating Co., Pittsburg, Pa., steam heating and plumbing the new six-story building at 1029 Fifth avenue, Pittsburg, for Trau & Loevner.

Barkley, Boughton & Crane Hardware Co., Fort Collins, Col., heating and plumbing the Y. M. C. A. building.

Johnson Foundry & Machine Co., Madison, Ind., heating and ventilating the new Eggleston School building.

MacGregor & Reid, Peterboro, Ont., heating the new Collegiate Institute building in Peterboro for $4,800.

Bartholomew Brothers, Zanesville, O., hot water heating and plumbing new apartment building on Market street for Dr. Knapp.



UTILITY Exhaust Muffler, Oil Separator, Return Tank Pump Governor and Feed Water Heater

UTILITY Vertical Steam Receiver and Separator

UTILITY Pump Governor Valve and Head

UTILITY Pump Governor Valve

UTILITY Steam Separator

UTILITY Pump Governor

UTILITY Exhaust Head

Specify **Utility** Specialties in your work and we will guarantee their value in use.

Send for Catalogue H

542-544 WEST BROADWAY, NEW YORK

A. T. Ward, Athol, Mass., new heating system for almshouse at Athol.

A. Burlingame Co., Worcester, Mass., heating addition to isolation hospital at Worcester for $7,698.

Huffman-Conklin Co., Columbus, Ohio, heating new eight-story bank and office building at Allegheny for the Real Estate, Savings & Trust Co.

Arthur Adams, Salt Lake City, Utah, installing steam heating plant in the Alpine district school.

M. F. Rourke Co., Knoxville, Tenn., installing heating apparatus in the Gratz School at its bid of $2,900, and in the Moses School at its bid of $2,125.

C. G. Smith & Son, Dixon, Ill., installing hot water heating plant in the Lee County Jail, for $1,000.

Alex. Zeck & Son, Charleston, W. Va., central heating plant for the West Virginia University at Grafton. The plant will supply steam to all the buildings of the institution and will cost $50,000.

Machinery & Electrical Co., Los Angeles, Cal., installing a heating and ventilating plant in the new library building for Claremont College.

Charles A. Rice, Claremont, N. H., heating and plumbing the new school building on Myrtle street.

Globe Heating Co., Des Moines, Ia., heating system for Drake Library. Consideration $14,000.

Brown Bros., Saginaw, Mich., steam heating apparatus for Bliss School.

J. H. Smith, Jacksonville, Fla., heating the new Oak Cliff School for $2,726.29.

Park County Hardware Co., Livingston, Mont., heating the hospital building at Fort Yellowstone, Wyo., for $2,560.

Alexander Thomson, Summit, N. J., heating and plumbing the Central Presbyterian Church.

William M. Carmen, Portland, Me., heating addition to the Congress Square Hotel in Portland.

Royal Heating Co., San Francisco, Cal., heating Alta Investment Company's building and the Oakland Bank of Savings, Oakland, with Van Auken system; heating Clunie Building and Jennings Building; also hot water heating system for the Santa Rosa Bank at Santa Rosa.

Columbus Heating and Ventilating Co., Columbus, Ohio, heating new high school building at Nelsonville.

Messner & Co., Cedar Rapids, Ia., heating new school building at that place.

John D. Torrey, Beaver, Pa., heating and plumbing 100 houses at Messina Springs, N. Y., for the Pittsburg Reduction Co.

American Warming and Ventilating Co., Pittsburg, Pa., heating and ventilating the new $100,000 public school building at Greenburg, Pa.

BOOKS ON HEATING AND VENTILATING

Heating and Ventilating Buildings

By ROLLA C. CARPENTER. Fourth Edition. Largely rewritten. 577 Pages. 277 Figures. Size, 6x9 inches. Cloth, $4.00.

A standard manual for heating engineers and architects. Includes chapters on exhaust steam heating and heating with electricity.

Baldwin on Heating; or, Steam Heating for Buildings (Revised).

By WILLIAM J. BALDWIN. Fifteenth Edition. Revised and Enlarged, 391 Pages. 131 Figures. Size, 5x7½ inches. Cloth, $2 50.

Contains descriptions of steam heating apparatus for warming and ventilating large buildings and private houses, with remarks and tables.

Questions and Answers on the Theory and Practice of Steam and Hot Water Heating

By R. M. STARBUCK 90 Pages. Pocket size. Illustrated. Cloth, $1.00.

A handy book for the steam fitter, containing tables and data, rules, and "tricks of the trade."

Mechanics of Ventilation

By GEORGE W. RAFTER. Pocket size. Boards, 50c. New and revised edition.

Modern Sanitary Plumbing, Steam and Hot Water Heating

By JAMES J. LAWLER. 400 Pages. 288 Illustrations. Size, 6x9 inches Price, $5.00.

This is the latest edition of Mr. Lawler's well known work on this subject.

Notes on Heating and Ventilation

By JOHN R. ALLEN. 152 Pages. 34 Illustrations. Size, 4½x6½ inches. Cloth, $2.00.

One of the new books, brought quite up to date, and containing much information to guide the intelligent steam fitter in the installation of heating and ventilating apparatus.

Ventilation of Buildings

By WILLIAM B. SNOW and THOMAS NOLAN. 88 Pages. Pocket size. Boards, 50c.

Just out. Contains a statement of the general principles of ventilation and of their application to different kinds of buildings.

Chimneys for Furnaces and Steam Boilers

By R. Armstrong. Pocket size. Boards, 50c.

Third American Edition. Revised and partly rewritten, with appendix on Theory of Chimney Draft, by F. E. Idell.

POST OR EXPRESSAGE PAID

THE HEATING AND VENTILATING MAGAZINE
1123 Broadway, New York

J. H. Cooney, Harrison, N. J., heating plants for Hitchings & Company's new building.

Fuller & Warren Co., Boston, Mass., heating and ventilating addition to the Endicott School building in Salem.

Frankfort Heating Co., Frankfort, Ind., hot water system for court house and jail.

G. & E. Blake, St. John, N. B., heating and plumbing the new Royal Bank building.

M. Isbester & Son, Saskatoon, Canada, heating and plumbing the new building for the National Trust Company.

Lewis & Kitchen, Kansas City, Mo., steam heating plant for the Allen, Fourth avenue and Avenue A school building at Hutchinson, Kan., at their bid of $8,240.

F. B. Sexton, Springfield, Ill., heating the new Carnegie library at Petersburg.

Wood-Davis Hardware Company, Sante Fe, N. M., heating and plumbing the new St. James' Mission School for Boys at its bid of $3,000.

Peter Johnson & Son, Decorah, Iowa, heating, ventilating and plumbing the new college dormitory at Decorah.

C. M. Masters, Mankato, Minn., steam heating the new Methodist Episcopal Church for $1,592.

J. S. Kearney Plumbing Co., Hattiesburg, Miss., heating two high school buildings at its bid of $3,920.

James E. Neff, Washington, Pa., heating the new Children's Home for $7,570.

W. S. Patterson Co., Appleton, Wis., combination heating plant for the court house at Eau Claire.

Archambo Heating & Plumbing Co., Minneapolis, Minn., heating the new High School building at Hector, Minn.

John G. Sutton Co., San Francisco, Cal., heating plant and hot water supply for four-story brick building on Eddy street for Charles Mayer.

Royal Heating Co., San Francisco, Cal., heating system and power plant for a three-story building at Battery and Washington streets.

Rourke Brothers Co., New Haven, Conn., heating, ventilating and plumbing Ivy Street School; heating and ventilating and plumbing St. Raphael's Hospital. This firm also has the contract for the heating, ventilating and plumbing for the addition to the East Haven school at Derby, and the heating system for the Polish Church at Derby.

J. J. Fitzgerald, Lexington, Ky., heating plant for the court house building.

W. G. Franklin, Parkersburg, W. Va., heating and ventilating the Adamston School at Clarksburg.

Modern Heating Co., Pittsburg, Pa., heating large amusement building at 12th and Carson streets.

Thermostatic Regulation

as manufactured
and installed by the

National Regulator Company

is the most simple and effective of any on the market.
For the proper control of Dampers and Valves in a
Heating Apparatus it has NO EQUAL.
Write for Catalogue and find out why.

CHICAGO
334 Dearborn St.

NEW YORK
1135 Broadway

Lane-Bowen Co., Lorain, Ohio, heating plant for the Penfield Avenue Savings Bank building.

Dewstoe & Brainard Co., Cleveland, Ohio, heating system for new office building of the Cleveland Forge and Iron Company.

B. F. Barbour Plumbing & Electrical Co., Birmingham, Ala., heating system and electrical apparatus for the new terminal station.

H. A. Miller, Wilmington, Del., heating the post office building at Sixth and King streets.

J. A. Hurley, Charlotte, N. C. steam heating plant and gas piping in the Masonic Temple at Raleigh, N. C.

Lloyd & Smith, Manistee, Mich., heating and plumbing the new Y. M. C. A. building at Cadillac for $5,000.

Norfolk Plumbing & Heating Co., Norfolk, Va., heating system for the court house at Oneill, W. Va., at its bid of $1,685.

Downey & Cruse, Milwaukee, Wis., central heating plant at the courthouse.

Kansas City Engineering Co., Kansas City, Mo., Paul vacuum system for the new Eagle building at Wichita, Kan.

Hoke Plumbing & Heating Co., Shreveport, La., heating plant for the Baton Rouge federal building.

J. H. Smith, Dallas, Texas, heating the new Oak Cliff school at his bid of $2,726.29.

Saxton Heating Co., Minneapolis, Minn., combination heating plant for the Burkholder Lumber Company at 25th and Aldrich avenues, South.

Arnold Evans Co., Seattle, Wash., heating addition to the high school building for $819.

Harry A. Miller, Wilmington, Del., heating system for the old federal building at Sixth and King streets.

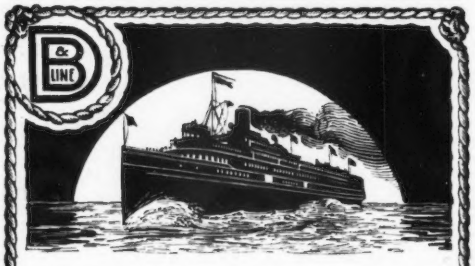
T. W. McFadden & Co., Muskegon, Mich., new heating system for portion of the court house building at Muskegon.

Johnson-Rowe-Daly Company, Omaha, Neb., steam heating plant for the A. Rosenberry apartment house at Sixteenth and California streets.

National Tube Co., Pittsburg, Pa., has been given the contract for 130 miles of pipe, from 10 to 20 inches in diameter, for the gas line of the Columbia Gas and Electric Company, which is to be laid through West Virginia. The contract will amount to nearly $4,000,000.

Western Heating Co., St. Louis, Mo., heating system for the $20,000 building for St. Peter's parish school at Kirkwood, Mo.

Sodemann Heat & Power Co., St. Louis, Mo., steam heating system for the $150,000 apartment building at Clara and Delmar avenues for G. C. Goodlett.



Across Lake Erie
BETWEEN
TWILIGHT AND DAWN

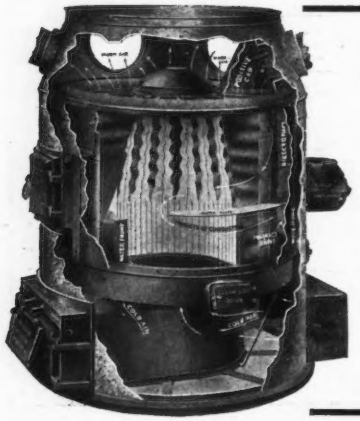
The D. & B. Line Steamers leave Detroit weekdays at 5:00 p. m., Sundays at 4:00 p. m. (central time) and from Buffalo daily at 5:30 p. m. (east rn time) reaching their destination the next morning. Direct connections with early morning trains. Superior service and lowest rates between eastern and western states.

Rail Tickets Available on Steamers

All classes of tickets sold reading via Michigan Central, Wabash and Grand Trunk railways between Detroit and Buffalo in either direction will be accepted for transportation on D. & B. Line Steamers.

Send two cent stamp for illustrated pamphlet. Address, A. A. Schantz, G. S. & P. T. M., Detroit, Mich.

DETROIT & BUFFALO STEAMBOAT CO.



30,000 HOMES
600 CHURCHES AND SCHOOLS
are being satisfactorily and economically heated by the
KELSEY
Warm Air Generator
SYSTEM

If you do not know all about the Kelsey, why not?
Send for Booklet and for 112 Page Book, "OPINIONS"

The Kelsey is unlike any furnace; warms fresh air by a better method; warms large volumes of air properly and forces into every room.

KELSEY HEATING COMPANY
307 Fayette St., Syracuse, N. Y. New York Office, 156 Fifth Ave.